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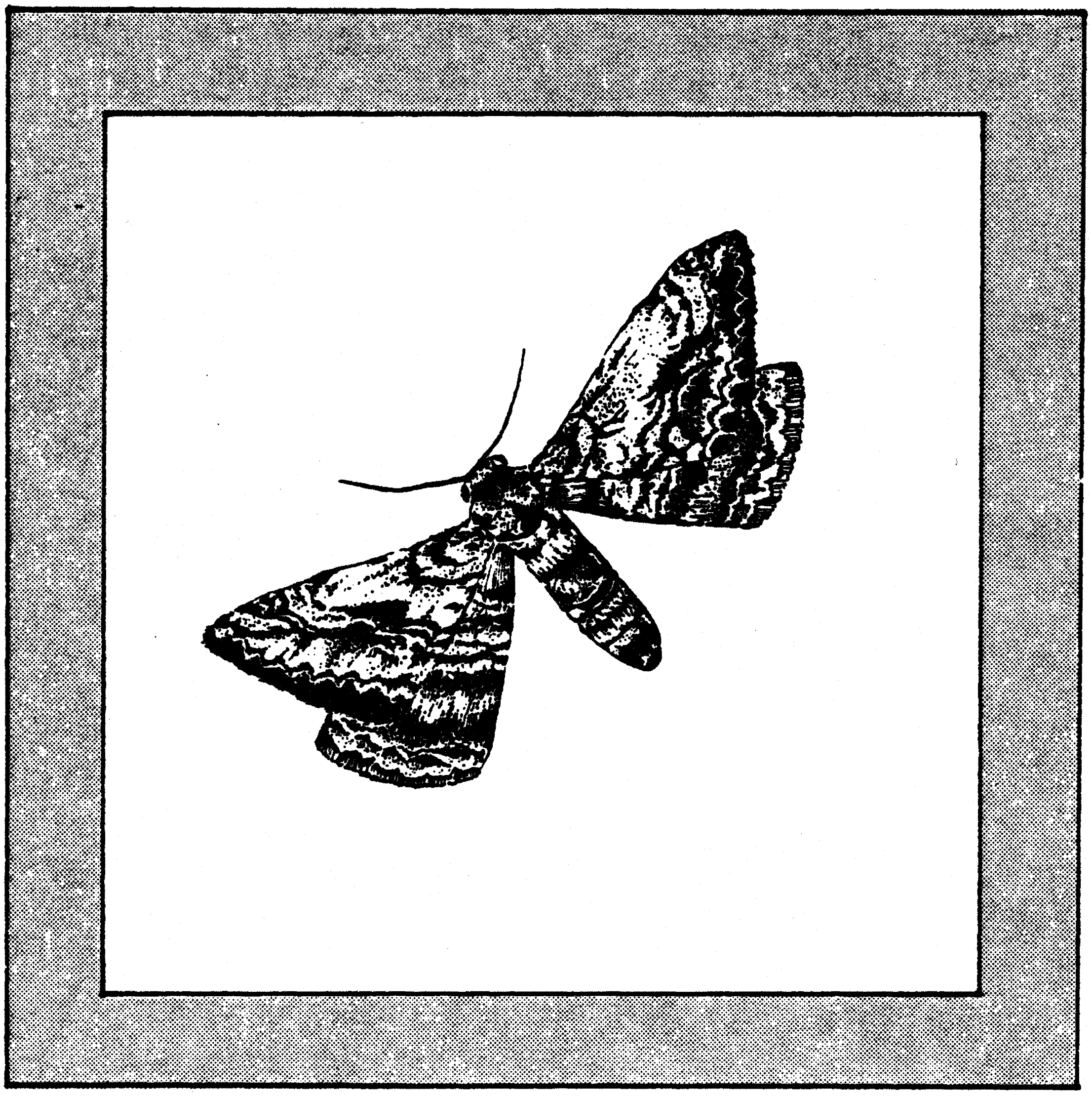
BIOLOGICAL AND WATER QUALITY MONITORING 1983 SPRUCE BUDWORM SPRAY PROJECT

NORTHEAST OREGON

(February 28,1984 Final Report)



USDA FOREST SERVICE
PACIFIC NORTHWEST REGION

OREGON STATE
DEPARTMENT OF FORESTRY

BIOLOGICAL AND WATER QUALITY MONITORING FOR THE 1983 SPRUCE BUDWORM PROJECT IN NORTHEAST OREGON 1/

I. INTRODUCTION

During June and July 1983, about 528,000 acres were treated with insecticides to control activity of the Western Spruce Budworm (WSBW) in Northeastern Oregon (Figure 1). Insecticides used included carbaryl (96% of treated area), mexacarbate (2%), and Bacillus thuringienses (2%). Substantial information relative to the Project and chemicals can be found in the Environmental Assessment for Western Spruce Budworm Management in Northeast Oregon, January 1983. William Hansen and Gene Silovsky had the responsibility to design and recommend an appropriate monitoring plan (Appendix A). Most of the planned monitoring was contracted out to Taxon Aquatic Monitoring Service from Corvallis, Oregon (Appendix B). Taxon also performed the monitoring in 1982 (Appendix P). Ideas, concerns, and information on monitoring was obtained from a number of agencies and individuals (Appendix C).

1/ Prepared by William F. Hansen, Siskiyou National Forest Hydrologist and Project Environmental Coordinator (transferred to Francis Marion and Sumter N.F., Columbia, S. Carolina) and Gene Silovsky, Fremont National Forest Wildlife Biologist and Assistant Environmental Coordinator on the Budworm Project.

The primary monitoring objective was to document environmental effects relative to the handling and application of insecticides. This included documentation of: (1) immediate effects to streams from 1983 spray application, (2) recovery of aquatic insect populations from some 1982 overspray areas, and (3) contingency monitoring as required by insecticide spills.

Nearly all of the monitoring effort was concentrated on aquatic ecosystems; however, a variety of concerns about the effects of spraying on terrestrial species surfaced. A major concern was impacts on bird populations, especially the atrical young, when insect populations rapidily decline after spraying. After reviewing pertinent literature on the topic and consulting with Dr. Henny of the U.S. Fish and Wildlife Service, we determined:

1. The complexity involved in designing monitoring studies concerning terrestrial indicator species were beyond the monetary and personnel allocations made in the monitoring segment of the spray project.

2. The types of monitoring requested by concerned individuals were more "long-term research oriented" rather than quality control/administrative in nature.

3. A large body of literature (a majority which was not identified in the project EA) exists. This literature identifies a range of effects on terrestrial species. The probable effects on terrestrial species, we felt, could be derived from this literature.

Monitoring of terrestrial species was not planned, however, brief observations were made for behavioral changes in animals encountered during the project.

II. PROCEDURES 1/

A. Identification of Key Areas

Key or sensitive areas to receive protection from spray application were located on a variety of maps for use by the spray contractor and project personnel. Although no terrestrial species monitoring was implemented, we did identify key use areas for "sensitive species", e.g., golden eagle nest sites. These were marked on maps and/or in the field and buffered from spray application. Most of this information came from local U.S. Forest Service or Oregon Department of Fish and Wildlife personnel.

A similar effort was used to identify flowing streams on project work maps. All flowing streams were to be protected by at least a 100 foot buffer on each side. Past experience indicated most second order streams which were identified on topographic maps were flowing during the June and July application period. Some adjustments were made for watershed size and topographic conditions when identifying flowing streams. All streams expected to be flowing water were identified on project work maps. Sensitive water users were also identified on maps as they became known. Information from local Forest Service personnel, Oregon Department

1/ Detailed procedures may be found in Appendices A, B, and D.

of Fish and Wildlife Biologists, and area Watermasters was used to identify critical areas. Private landowners were notified with news releases and/or personal contacts.

Letters were also sent to area beekeepers to warn them about the possible hazard of insecticide use near bees. There were no known problems associated with hives being planted in or adjacent to the treatment area.

B. Types of Monitoring

Three major types of monitoring were used:

1. Quality Control Monitoring - most of the project monitoring dealt with changes in aquatic insect populations and related to the application of insecticide in 1983. Evaluation of spray deposit cards placed adjacent to streams, dye tracer used in the spray mixture, and laboratory analysis of water samples was also included.

Much of the quality control monitoring was completed by contract with Taxon Aquatic Monitoring Service. Detailed procedures can be found in Appendices A, B, and D. The monitoring contract consists of details relative to the collection of the following types of information:

a. Aquatic Insects/Water

i. At eighteen primary sampling locations, aquatic drift and benthic insects were sampled and later enumerated by order for

pre and post spray conditions. Water samples were taken before and after insecticide spray application. Post spray samples were often collected over a period of time. Grab and composite samples were field extracted to fix insecticide levels. Observations were also made to better qualify timing or quality of treatment, and environmental conditions.

ii. Thirty-one secondary monitoring stations were identified where less intense pre and post treatment aquatic insect drift sampling occurred. Benthic and water samples were not required but were taken when the monitoring person noticed unusually high insect drift or an oil film on the water surface. Information at these secondary sites was collected to better document application control near smaller streams.

iii. Benthic samples were collected from five 1982 and several 1983 monitoring sites where known or probable stream overspray or heavy insecticide drift occurred. Data collected were used to evaluate recovery of aquatic insects, especially stoneflies.

Some changes in the original water monitoring contract occurred because a few preselected sites did not fit field conditions or notification of spraying did not give enough lead time to the contractor. Monitoring similar to that in the contract was also carried out by Hansen and Silovsky. Other monitoring methods were also helpful and include the following:

b. Spray Deposit Cards

Spray desposit cards sensitive to oil or dye in the insecticide mixture, were deliberately or by chance placed in stream buffers. These were evaluated for the amount of spray deposit.

c. Dyes Placed In Insecticides

A portion of the insecticide mexacarbate (Zectran) was dyed with Rhodamine BT fluorescent dye. Numerous water grab samples for streams in the units treated with dyed Zectran were taken for many hours after spray application. The amount of dye present was determined with a fluorometer and was used to estimate insecticide concentrations.

d. Field Observations

Numerous hours of field observation were also made by Hansen, Silovsky, and other project workers in conjunction with the spray application or insecticide spills. Many of these observations have been documented to help other monitoring efforts (Appendix E).

2. Contingency Monitoring - more intense monitoring was necessary for accidents which occurred during the project (Appendix A - pages 4 and 5). The Willow Creek spill would be classed as a major accident and spill into a stream.

3. Non-Target Organism Monitoring - consisted of observations for noticeable changes in animal behavior following insecticide treatment. Except on the Willow Creek spill, few noticeable changes in vertebrate behavior were seen. Substantial changes in aquatic invertebrate numbers and kinds were documented.

III. RESULTS OF QUALITY CONTROL MONITORING

A. Aquatic Insects

Aquatic insects from stream benthos and detached benthos (insect drift) were used as indicators of stream protection from insecticide drift or overspray. They are good indicators because of their sensitivity to low levels of insecticides. One study indicated 50% of the stoneflies were killed at a concentration of 5 ppb carbaryl. Sensitive fish such as chinook (estimated LD50 concentration of 5 ppm carbaryl) salmon appear able to withstand concentrations that are hundreds of times larger.

For the most sensitive fish to get a lethal dose of carbaryl (5 ppm), a direct overspray of 1 lb. active ingredient carbaryl per acre must occur in water with a depth of 0.074 ft. Direct overspray of deeper streams for example one foot in depth, would only result in a concentration of 370 ppb (Appendix A). Direct mortality to fish life from an overspray was not very probable on this project. Conversely mortality of aquatic insects had a high probability of occurring when streams were oversprayed with carbaryl.

1. Primary Sites

Table 1 summarizes the results from the primary monitoring sites. Primary sites were generally located in the larger or "more valuable" fishery streams. Of the 20 primary sites monitored, 60% had large enough changes in aquatic insects to suggest that insecticide drift or overspray occurred. Of the 12 primary sites with medium to high changes in aquatic insect populations, Bridge Creek, Cottonwood Creek, Deer Creek, Potamus Creek, and Wolf Creek were known to have reaches oversprayed from on-site observations and/or communications with aerial observers or other field personnel.

Spray application usually occurred over numerous days within a treated watershed. Monitoring was adjusted as necessary to obtain information when treatment occurred along major streams and tributaries. The aquatic drift monitoring was done when most of the important areas adjacent to that site were treated. Effects from upstream treatment areas may have gone unnoticed in the drift information due to stream travel times or treatment on other than sampling days. Benthic information collected should have picked up significant changes from accidental treatment of tributary streams. Poor to sometimes non-existent communications with aerial application personnel reduced the effectiveness of the monitoring at several sites.

When interpreting Table 1 concerning insect population changes, it should be noted that substantial variation can and does exist under natural conditions as stated in the 1983 report by Taxon (Appendix D). Several

Table 1: Primary Monitoring Data Summary by Site 1983 Western Spruce Budworm Project.

Stream (Entomological Unit)	Insect Benthic Decrease Factor Pre/Post 1/	Aquatic Insect Drift Rate Increase Factor Post/Pre 2/	Relative Extent of Change 3/	Water Sample (carbaryl in ppb) C-N=composite with N subsamples
Bridge Cr. (P.A.)	1.4	9	Med.-High	1.4 C-5
Bully Cr. (Putney Mtn)	Lost	114	High	43. C-6
Clear Creek (P.A.)	.2	1.3	None	1.3 C-4
Cottonwood Cr. (Logan S.2)	2.6	69	High	47.
Deer Cr. (Aldrich)	3.8	5	Med.-High	4.4 C-3
Fivemile Cr. (Matlock)	.3	.9	None	4.1 C-4
Idaho (Pogue Pt.2)	1.4	3	Low	*
Indian Cr. (Putney Mtn)	Lost	5	Medium	*
John Day River (Logan N)	.5	4	Medium	*
Lane Cr. (Pearson)	2.4	173	High	5.0 C-4
Mallory Cr. (Matlock)	Lost	.6	None	*
Meadow Brook, West Fork (Putney Mtn)	2.1	2	Medium	1.2 C-5
Murderers Cr. (Aldrich)	1.0	2	Low	2.7 C-5
Potamus Cr. (Matlock)	1.7	23	High	Lost C-5
Rudio Cr. (Rudio)	.9	.8	None	*
Stony Cr. (Matlock)	2.0	.5	Medium	*
Summit Cr. (Pogue Pt.2)	3.1	.5	None	*
Summit Cr. (Logan S.2)	.9	.5	None	*
Tex Cr. (Aldrich)	1.2	5	Medium	1.7 C-4
Wolf Creek (Logan S.1)	1.1	9	Med.-High	3.0 C-4

1/ Benthic decrease factor was calculated by dividing the sensitive (Stonefly, mayfly, and caddisfly) insect benthic population after spraying into the before spraying population. Values below 1.0 indicate more insects following spray and values above 1.0 indicate fewer benthic insects following treatment which may be a result of insecticide.

2/ Drift rate increase in insects is found by dividing the before spray drift rate into the after spray drift rate. Values below 1.0 indicate fewer insects drifting following treatment while values above 1.0 indicate more insects drifting after insecticide application.

3/ Subjective rating classifying the extent of insect population change. Insect drift increase factor was largely used to determine this value with None = 0-1.5, Low = 1.5-3.9, Medium = 4.0-7.9, Medium-High = 8.0-10.9, High = 11.0 or larger. Information from benthic, water samples, or other data was used as necessary to adjust to level considered appropriate.

Change Catagory Summary

Category	Number of Stations	% of Total
None	6	30
Low	2	10
Medium	5	25
Medium-High	3	15
High	4	20

* No water samples analyzed due to low changes in insect drift or benthic populations or no samples taken.

of the monitoring sites had larger benthic insect populations after treatment. To some extent this can be expected as aquatic insect numbers increase throughout the summer. Substantial decreases in post spray drift are more difficult to explain but could be due to drift net location, previous insecticide treatment in tributaries which had a downstream effect, or other environmental conditions.

Post stray benthic samples are representative of what aquatic insects were left after treatment. Benthic samples were taken after all spray blocks were treated in the watershed. Dead aquatic insects rapidly decompose and it was felt they would not be a factor in the post benthic samples.

The benthic insect decrease in Stony Creek (Table 1) may have been due to some upstream insecticide drift or overspray in the drainage which occurred before or after the sampling occurred. Drift sampling was normally accomplished for the first few days that the watershed was being treated. Infrequently tributaries may have been treated before drift sampling occurred at the primary sites. Secondary sites were occasionally moved to sample streams tributary to primary monitoring sites. The magnitude of the application project and the rapid change in treatment areas sometimes made monitoring very difficult. Weather conditions in the Potamus, Mallory, and Stony drainages caused long delays in treatment.

Mexacarbate (Zectran) was the insecticide used to treat the Entomological Unit Pogue Point 2. A fluorescent tracer dye, Rhodamine BT base, was utilized in much of the spray mixture in Pogue Point 2 to help quantify

contamination levels in these streams. Results of the fluorescent tests indicated that very little detectable stream contamination occurred due to drift or overspray.

Data and interpretations relative to the Pogue Point 2 area is presented in Appendix F. Benthic populations in Summit and Idaho Creeks declined but drift changes were nondetectable to low. Silovsky and Hansen found mayflies and caddisflies in upper Summit Creek under stress, but still alive immediately after the area was sprayed.

2. Secondary Sites

Of the 34 secondary sites sampled for aquatic drift, 14 (41%) had a medium to high increase in insect drift rates; i.e. increase in post treatment/pretreatment drift was a factor of 4 or larger (Table 2). Table 3 summarizes information collected from primary and secondary sites. Of the 53 primary and secondary sites monitored, 26 sites (49%) had medium to high changes.

Several of the secondary sites hit with insecticide drift or spray had an apparent downstream influence, and a discussion follows. As the insecticide moves downstream in the water, the following factors lessen its effects on aquatic insects: (a) dilution from larger stream volumes, (b) dilution from the delay or collection of contaminates in pools or eddies (c) sorption of insecticide, and (d) chemical breakdown. The amount of down stream influence was also lessened because not all streams were accidentally oversprayed and treatments within a watershed were spread out over several days.

Table 2: Secondary Monitoring Site Summary 1983 Spruce Budworm Project 1/

Stream (Entomological Unit)	Benthic Decrease Factor Pre/Post	Aquatic Insects Drift Rate Increase Factor - Post/Pre	Relative Extent of Change
Alder (Logan S.2)		38*	High*
Bridge, Upper (P.A.)		Lost	
Bridge, S.F. (P.A.)		5*	Medium*
Bully, Upper (Putney Mtn)		1.1	None
Cow-overspray (King)		8*	Med.-high*
Corral (Aldrich)		7*	Medium*
Deer, Upper (Aldrich)		.1	None
Deer, S.Fork (Aldrich)		10	Med.-high
Deer, N.Fork (Aldrich)		2	Low
Fivemile, Upper (Matlock)		Lost	
Gilmore (Rudio)		26	High
Indian, mid (Putney Mtn)		0.0	None
Indian, Upper (Putney Mtn)		.3	None
John Day, Upper (Logan N.)		4	Medium
Larch (Logan S.2)		3	Low
Little Wilson (Miller Prairie)		1.1	None
Lunch (P.A.)		.1	None
Meadow Brook, W.F. Upper (Putney Mtn)		17	High
Meadow Brook, E.F. Lower (Putney Mtn)		12	High
Meadow Brook, E.F. Upper (Putney Mtn)		.2	None
Murderers, Middle (Aldrich)		0.0	None
Murderers, Upper (Aldrich)		.4	None
Murderers, S.Fork (Aldrich)		.8	None
No Name (Logan North)		2	Low
Roberts (Logan North)		2	Low
Rudio, Upper (Rudio)		4	Low
Sugar (Aldrich)		17	High
Summit, Lower (Pogue Pt.2)		.9	None
Thorpe (Aldrich)		1.0	None
Vester (Aldrich)		1.7	Low
White (Aldrich)		17	High
Wickiup (Logan S.2)		27	High
Wilson, (Miller Prairie)	7.9		High
Wolf, E.Fork (Logan S.1)		2	Low
Wolf, Middle Fork (Logan S.1)		3	Low
Wolf, West Fork (Logan S.1)		13	High

* = estimated value from mean prespray information from other sites or observations

1/ Refer to Table 1 for discussion of headings or criteria.

Table 3: Summary of Initial Relative Change from Tables 1 and 2. 1/

Extent of Initial Change in Aquatic Insects

None	Low	Medium	Medium-High	High
Bully, Up	Fivemile, Up	Bridge	Cow-overspray	Alder
Clear	Larch	Bridge, S.F.	Deer	Bully
Deer, Up	Murderers	Corral	Deer, S.F.	Cottonwood
Fivemile	No Name (Logan N)	Indian		Gilmore
Indian, Mid	Roberts	John Day, Up		Lane
Indian, Up	Rudio,Up	John Day, Up		Meadow Brook, W.F. Up.
Little Wilson	Vester	Meadow Brook, W.F.		Meadow Brook, E.F., Lo
Lunch	Wolf, E.F.	Stony		Potamus
Mallory	Wolf, M.F.	Tex		Sugar
Meadow Brook, E.F.Up				White
Murderers, Mid				Wickiup
Murderers, Up				Wilson
Murderers, S.F.				Wolf, W.F.
Rudio				
Summit Up				
Summit Low				
Summit (Logan)				
Thorpe				

1/ Change categories presented in this table are subjective. Insect drift was used as the most sensitive indicator ofpossible stream contamination with insecticides. If there was uncertainty as to when the area was treated or if the monitoring coincided with the treatment, then more weight was placed on changes in benthic populations. The following category values were used to divide the data into groups:

1. None - indicates change in drift factor was less than 1.5.
2. Low - change in drift factor from 1.5 to 3.9.
3. Medium - change in drift factor from 4.0 to 7.9
4. Medium-High - change in drift factor from 8.0 to 10.9
5. High - change in drift factor greater than 11

The following summarizes the number of monitoring sites per category:

Category	Number of Stations	% of Total
None	18	34
Low	9	17
Medium	9	17
Medium-High	4	8
High	13	25

The information collected suggest that effects due to pesticide overspray become lower in magnitude as they move downstream. Table 4 presents the interactions between sites in Table 3, where significant changes were found in tributary areas above a primary monitoring site. In evaluating this information the effect on the downstream site may be due to direct application or insecticide drift above the site and/or it may be due to the application to tributary areas which in turn influenced the downstream site.

B. Spray Deposit Cards

Spray deposit cards were deliberately placed in stream buffer areas to evaluate the effectiveness of the buffer in reducing insecticide spray or drift. Spray deposit cards were also being placed in forest stands to evaluate spray deposits on the budworm. Some of these cards were placed in stream buffers by chance and provided another opportunity to check the effectivenss of buffers. All flowing streams were to have at least 100 foot wide buffers on each side from insecticide treatment. Project maps showing flowing streams were supplied to project and contractor personnel.

Table 4: Downstream Effects Resulting From Upstream Treatment with Insecticides

A. Downstream Monitoring Site	Drift Increase Factor	B. Tributary Monitoring Site Above A	Drift Increase Factor	C. Tributary Monitoring Site Above B	Drift Increase Factor
Meadow Brook	2	MBWFU	17		
Deer	5	Corral	7		
John Day	4	John Day Up	4		
Murderers	2	Tex	5	Sugar	17
Wolf	9	E.F. Wolf	2		
		M.F. Wolf	3		
		W.F. Wolf	13		

1. <u>Deliberately Placed Cards</u>

To test the effectiveness of these buffers oil/pesticide sensitive cards (about 3" x 5") placed adjacent to streams at ground level were evaluated (Table 5). A majority of these cards were under a partial tree and/or shrub canopy and some spray was intercepted before it reached the ground and cards.

Card lines were placed perpendicular to 17 small streams, 1.5 to 15 feet in width (Table 5). Of the 17 streams, 11 (59%) received pesticide spray deposits on one or both banks with readings greater than or equal to 1.0 (very light). Seven of these (41.0%) received spray deposit on one or both banks with readings greater than or equal to 2.0 (light).

Field observations were made by Silovsky (during spray card collections) at Cat, Alder, Cottonwood and Crane Creeks one to four hours after spray application (Appendix G). Observations indicate spray deposits greater than or equal to 2.0 (light) result in obvious down stream drift of dead/distressed mayfly, caddisfly and stonefly larvae or pupae.

An estimate of the streams aerial visibility was made at the 17 card line sites. Nine streams had low visibility, 4 moderate visibility and 4 high visibility. Seven (78%) of the 9 streams with low visibility, 3 (75%) of the 4 streams with moderate visibility, and 2 (50%) of the 4 streams with high visibility were hit with spray. The lower the visibility of a stream from the air, the greater was the probability it would be hit by spray; however, a majority (63%) of streams with moderate or high aerial

Table 5. Data From Spray Deposit Cards Deliberately Placed Perpendicular to Streams.

ENTOMOLOGICAL UNIT	SPRAY BLOCKS	STREAM NAME	STREAM WIDTH (ft)	SPRAY CARD LOCATION IN FEET AMOUNT OF SPRAY DEPOSIT* 100	80	60	40	20	LB**	RB**	20	40	60	80	100	AERIAL VISABILITY
Logan S. 2	5 & 4	Tamarack	2.5	V	0	1	0	0	0	0	0	0	0	0	0	LO
Logan S. 2	4 & 6	Crane	2.5	0	0	0	0	0	0	0	0	0	0	0	0	HI
Logan S. 2	8	Cat	4.0	V	V	3	3	3	V	2	2	1	4	3	3	LO
PA	2	Lunch Tributary	2.5	0	0	0	0	0	0	V	0	0	0	1	2	HI
PA	2	SO. FR. Bridge	2.5	0	0	0	0	0	0	0	V	0	0	0	V	LO
PA	1	N. Fr. Bridge	2.0	4	4	1	1	V	2	2	2	2	2	2	2	LO
Logan S. 2	4/6	Crane	2.0	1	2	3	4	4	4	4	2	2	V	V	0	MOD
Logan S.2	8/9	Alder	6.0	3	2	1	2	2	V	2	1	1	1	1	0	HI
PA	6	Lunch	6.0	2	3	3	V	1	V	V	1	1	1	1	1	MOD
Logan S. 2	9	Cottonwood	12-15	1	1	1	2	2	2	2	2	2	2	2	2	HI
PA	2	Clear	6-8	1	1	1	1	1	1	1	1	1	1	0	1	LO
Logan S. 2	4	Crane Tributary	6-8	2	1	1	2	1	2	1	1	2	2	2	2	LO
Pogue Pt. 2	3	N. Fr. Summit	1.5	2	3	3	3	1	1	0	1	1	0	0	0	LO
Logan So. 2	8/7	Cougar	6	2	1	1	0	0	0	0	0	0	0	0	0	MOD
Pogue Pt. 2	3	N. FR. Summit	2.5	NC	NC	1	2	2	2	1	1	2	NC	NC	NC	LO
Pogue Pt. 2	1	Idaho	4.5	1	0	1	1	V	0	1	0	1	1	1	0	LO
Pogue Pt. 2	1	Idaho	1.5	3	2	1	1	0	1	1	0	1	2	2	2	MOD
		Means	1.6	1.3	1.3	1.3	1.3	1.1	1.1	1.1	0.9	1.0	1.0	1.0	1.0	

* 0 - No Spray, 1 - Very Light, 2 - Light, 3 - Moderate, 4 - Heavy, V - Void (Card Removed/Destroyed by animals), NC - No Card Placed

** LB - Left Bank, RB - Right Bank

visibility were also hit with spray. Although the sample size is relatively small it appears representative of the effectiveness of buffers along small streams during the 1983 spray project.

The length of the streams segments sprayed could not be "reasonably" determined from this sample. Often spray cards were picked up a day after spraying. In some cases (Cat, Alder, and Cottonwood Creeks) the overspray was extensive, 2 to 5 miles. An analysis of this data, coupled with the small sample size, would probably not provide an unbiased opportunity to estimate the actual stream mileage oversprayed.

2. Spray Cards Placed by Chance

Spray cards were placed in forest stands to measure the effectiveness of spray application on the Western Spruce Budworm. Some of these spray cards, by chance, fell within stream buffers (Table 6).

There were 34 "samples" that occurred by chance in buffers. Nine samples (26%) contained no spray deposit. Another 8 (24%) samples contained spray deposits ranging from .1 to .9 (none to very light) and 17 (50%) contained spray deposits ranging from 1.0 (very light) to 4.0 (heavy). Eleven of these (32%) samples had spray deposits greater than 2.0 (light). The presence of spray deposits ranging from .1 to .9 suggest insecticide drift. Readings between 1.0 (very light) and 2.0 (light) could be either heavy drift or very close application to streams. Deposits greater than or equal to 2.0 (light) are usually indicative of direct spray application.

Table 6. Data from the Chance Placement of Spray Deposit Cards Adjacent to Streams.

ENTOMOLOGICAL UNIT	SPRAY BLOCK	NO. CARDS IN BUFFER	MEAN SPRAY DEPOSIT*
Aldrich	19	7	2.7
	29	2	"Very Light"
	33	1	0
	46	1	.2
	50	2	1.0
	52	1	.5
	64	2	0
	68	1	2.0
	76	3	.7
	77	6	.1
	77	7	1.4
Rudio Mountain	01	2	4.0
	02	1	0
	03	1	0
	04	2	0
	04	4	.5
PA	02/03	5	1.3
Snow	--	2	0
	--	1	.5
	--	5	.6
Miller Prairie I.S.	38	2	0
	35	2	2.0
	18	1	4.0
	39	2	2.5
Miller Prairie 2	01	1	4.0
Putney Mountain	07	1	2.0
	08	1	0
	17	2	1.0
Logan S. 2	01	10	1.2
	04	1	1.0
	13	?	1.0 to 4.0
Logan N.	21	1	4.0
	24	3	0
	24	1	3.0

* 0 - No Spray, 1 - Very Light, 2 - Light, 3 - Moderate, 4 - Heavy

The data collected did not indicate the extent of streams hit with spray. It is reasonable to assume "similar" percentages of both the buffers and streams were hit with spray. No estimates of the lengths of streams sprayed were possible from this data. About 32% of the samples contained enough spray deposits to cause significant aquatic insect mortality at downstream sites.

C. Laboratory Analysis

Laboratory analysis of pesticide was used as another method to confirm the presence of chemicals when information suggested that contamination occurred. The samples collected were field extracted to preserve the samples for later analysis. Sampling methods are presented in Appendices A (Section II C), B (page 22-23), and D (page 1). No attempt was made to quantify peak stream contamination levels due to drift or overspray. Additional water samples were collected in association with the following areas due to overspray:

1. Cottonwood Creek
2. Cat Creek
3. Wolf Creek
4. Cow Creek

Analysis results from Columbia Laboratories, Inc. are found in Appendix O. Table 7 presents in more detail the actual sampling dates, times, and locations.

Table 7: Results of Insecticide Analysis in Quality Control Water Samples, 1983.

Stream	Type or Location of Monitoring Station	Date(s) Time(s) Sample Collected	Number of Sub Samples in Composite Samples	Results of Insecticide Anaysis (ppb)	Time When Rain Noted
Bridge	Primary	7/5 0510, 0644, 1258, 2305 7/6 0405	5	1.4 carbaryl	
Bully	Primary	6/26 0543, 0743, 1200, 1925, 2330, 6/27 0530	6	42.8 carbaryl	6/26 1925
Clear	Primary	7/5 0528, 0700, 1325, 1715, 2300 7/6 0430	6	1.3 carbaryl	
Cat	Secondary	7/8 0942	1	53 carbaryl	
Cotton-wood	Primary	7/7 0740, 1020, 1451, 1815, 7/8 0500	5		
	Grab 1.5 mi. below Primary	7/8 1225	1	47 carbaryl	
	Primary	7/9 0635	1	9.5 carbaryl	
	Grab at 5.5, 6.7, 8 miles below Primary	7/9 0857-0930	3	3.7 carbaryl	
Cow	Secondary	7/11 1030			
Deer	Primary	7/6 1100 1945 7/7 0410			
Fivemile	Primary	6/16 1900, 6/17 0000, 0500, 0820	4	4.1 carbaryl	
Lane	Primary	6/28 1515, 1910 6/29 1055, 1420	4	5.0 Carbaryl	Some rain between 19 and 1055
Meadow Brook	Primary	6/18 0810, 1106, 1545 6/19 0150, 0610	5	1.2 carbaryl	
Mur-derers	Primary	6/20 1130, 2000 6/21 0345, 1025	5	2.7 carbaryl	

Table 7: Results of Insecticide Analysis in Quality Control Water Samples (Cont'd).

Stream	Type or Location of Monitoring Station	Date(s) Time(s) Sample Collected	Number of Sub Samples in Composite Samples	Results of Insecticide Anaysis (ppb)	Time When Rain Noted
Potamus	Primary	6/28 1400, 1810, 2140 6/29 0325, 1500	5	Lost	
Summit (Pogue Pt. 2)	Grab above Primary site	7/4/83 0904	1	Not detected mexacarbate	
Tex	Primary	6/20 0848, 2133 6/21 0415, 1045	4	1.7 carbaryl	
Wolf	Primary	6/30 1015, 1135, 1845 7/1 0645	4	3.0 carbaryl	Rained evening o 6/30
	Primary	6/30 1148		3.2 carbaryl	

Sampling for insecticides in water was not relied upon more heavily for the following reasons: (1) To properly characterize a pesticide contamination curve, numerous samples must be collected, field extracted, and later analyzed in a laboratory. (2) Unless sampling is properly done, grab samples at one point in time often give a false sense of security (nothing was found). (3) Stream travel times must be taken into account when water sampling for pesticides. (4) Aquatic insects are continuously present to sample the water and are quite sensitive to insecticide contamination.

Water sampling could have been less intense than planned and still produced meaningful results. In most cases the water composite sampling over one day's time was able to sample between one and ten miles of stream. Contamination from headwater areas was likely not noticed at primary sites unless they were close to the primary site or treated earlier than the date when monitoring began at the primary site. Much of the information for individual areas within Entomological Units was not captured in sufficient detail to determine the timing of application.

D. Dye Tracer

A flourescent tracer dye was utilized in much of the spray mixture for the Pogue Point 2 area treated with mexacarbate. Because mexcarbate was applied at a lower rate/acre (.125 lbs), it was quite inexpensive to use Rhodamine BT base with the spray mixture. The initial plan was to add a 200-400 foot treatment strip adjacent to all streams in the unit containing a mixture of chemical plus dye; therefore, only a

portion of the dye needed to treat the whole area was ordered. The application contract did not include these special needs and it was decided that treatment should be similar to other units. Dye was only applied to about 2/3 of the area with the most streams.

Numerous water samples were collected for dye analysis by taking grab samples and using ISCO automatic water sampling devices. Detailed information is presented in Appendix F. Since large amounts of dye were not recorded in water samples and aquatic drift information indicated no large changes on Summit and Idaho Creeks, it is expected that little impact occurred. Spray cards placed in the buffers of these streams indicated generally very light drift reached these streams (Table 5).

The water sample taken at 2 miles above the primary site (Summit Creek, upper) had a slight concentration of dye and expected mexacarbate concentration of 1 ppb. Aquatic insects were also stressed at this location with mayflies and caddisflies disoriented and in plain sight away from their normal hiding niches. Laboratory analysis of this sample indicated no detectable concentration of mexacarbate.

In comparison to the insecticide carbaryl which was applied at 1 lb./acre, mexacarbate rates were 0.125 lb/acre. Insecticide concentrations for the mexacarbate area were expected to be one-eigth of those typically found in carbaryl treated areas. In this unit more care was taken to achieve quality control. In addition the probability of detecting this insecticide was less due to the application rate.

Use of tracer dyes to aid quality control monitoring were helpful, but on such large scale projects, the costs may outweigh the benefits. Tracer dye use with mexacarbate (Zectran) was inexpensive, while use with carbaryl (Sevin-4-oil) would have required a real committment to this method of monitoring due to costs, manpower, and equipment.

III. RESULTS OF CONTINGENCY MONITORING

During the 1983 Western Spruce Budworm Suppression Project, several accidents occurred which required some degree of contingency monitoring (Appendix A I.b. 3). The Willow Creek spill near Heppner, Oregon will long be remembered as a severe pesticide transport accident (Appendix H). Other less severe spills will also be included in this report but in less detail. They included Miller Prairie spill, Service Creek Road spill, helicopter crash near Fossil, Oregon; helicopter crash near Antelope Mountain; and helicopter crash/spill into Cow Creek.

A. Willow Creek Spill

On June 13, 1983, about 4:30 a.m., a pesticide transport truck lost its brakes and control, dumping about 1,900 gallons of Sevin-4-Oil directly into Willow Creek. The pesticide mixture included 950 gallons of diesel and 950 gallons of Sevin-4-Oil (3,800 lbs. of carbaryl). In a 10-day period, about 900 lbs. of carbaryl (or 1-napthanol) reached the Heppner reservoir beginning on June 14, 1983, at 6:00 a.m. (Appendix H, Table 2). Esentially all aquatic vertebrates and invertebrates (fish, lampreys, crayfish, aquatic insects, etc.) were killed in the 21 plus miles

of stream between the spill site and the reservoir. Aquatic biologists with the Oregon Department of Environmental Quality indicated that they had never seen a stream system more completely killed from a chemical spill.

In September 1983, Taxon Aquatic Monitoring Service was secured to accomplish aquatic insect sampling at 16 sites located at various points along Willow Creek and its larger tributaries (Appendix I). The data indicates that aquatic insects are recovering faster than expected from the spill. The upper reaches of Willow Creek were the most affected. Cleanup operations to Cutsforth Pond were occurring as much as a month after the spill due to substantial amounts of carbaryl within gravel, soil, and woody debris along the stream margins and eddy areas.

Stoneflies continue to be the order most affected by the spill with very low numbers and diversity when compared to unaffected tributary areas. Other insects like the black flies (family Simulidae) and midges (family Chironomidae) have rapidly returned in unusually high numbers. Apparently organisms which normally prey on these species have not returned in sufficient numbers to keep the population in balance. A more detailed discussion of aquatic insect recovery is presented in the Results of Non-Target Organism Monitoring.

Jerry Bell and Krystyna Wolniakowski, Oregon DEQ, are monitoring changes in aquatic insects and algae production. Future monitoring is expected on Willow Creek as an interagency task force is being developed to address information collection, compilation, and transfer needs.
Followup monitoring reports will be coordinated through them.

B. Miller Prairie Spill

On June 16, 1983, a helicopter pesticide holding tank shifted, causing the need for an immediate landing. The hose connected to the mix tank pulled loose and the carbaryl mixture was being released inside the cockpit. The pilot tilted the ship backwards and opened the spray nozzles to avoid getting flooded with the mixture. In the process of landing, a marshy area was sprayed and dripped on. Most of the remaining chemical leaked out onto the ground a short distance from the marshy area. Nearly all of the insecticide from the leak was confined to dry land.

Data collected suggests that impacts to aquatic insects should have been moderate to high in the immediate vacinity of the spill in Indian Creek. Effects on Chapin Creek were not monitored but a substantial opportunity for downstream dilution existed. This suggested that changes in aquatic life would be small. More details related to this spill are presented in Appendix K.

C. Service Creek Road Spill

The morning of June 20, 1983, Gene and I found out about a chemical leak along the road near Service Creek, Oregon. No surface water was involved in the tanker leak that reportedly spilled several gallons of chemical as it was being transported to a helispot.

The spill started as a very small leak or dripping of the hose nozzle starting at Service Creek, OR, going north on Highway 19. This small leak continued for approximately 10 miles and resulted from the hose

and nozzle being dragged along the highway. The final 3.5-4 miles of the spill was much larger, showing up as a 14" wide strip weaving back and forth along the highway. The nozzle had finally broken off and chemical was pouring out of the hose as the truck was traveling. We talked with Bill Miller, heliport manager, about the spill and estimated 50 gallons of chemical mixture was probably lost.

The spill did not have any apparent immediate effect to area streams as the chemical dried on the pavement or soaked into the road shoulder. Because there was a large distance between the spill and streams we though that contamination of streams was not a major concern. No other followup monitoring was accomplished. We recommended that the major part of the spill be covered with lime to promote decomposition.

D. Spill Near Fossil Oregon

On June 24, 1983, Brad Bales (ODFW) and Bill Hansen investigated the helicopter crash near Fossil, Oregon. The helicopter was totaled but most of the insecticide was still in the tank. Some chemical soaked into the ground but the area was near the ridge top on a slight slope. There was no apparent problem to the water resource. Lime was used on noticeable spill areas to help promote chemical breakdown.

E. Spill Near Antelope Mountain

Gene Silovsky prepared a summary of the July 6, 1983, helicopter crash and spill containment near Antelope Mountain (Appendix L). Little probability existed for movement of the chemical into water.

F. Cow Creek Spill

On July 13, 1983, another helicopter crash occurred in the King Entomological unit. About 100 gallons of carbaryl mixture spilled into a wet meadow in upper Cow Creek. Detailed information is presented in Appendix M. The effects were primarily to downstream aquatic insects for several miles. The stream's insects had already experienced heavy mortality due to an overflight on July 12.

IV. NON-TARGET SPECIES MONITORING

A. Invertebrate Organisms

Our monitoring of invertebrate organisms was restricted to aquatic insects; however, Torgie Torgeson (PNW Experiment Station) collected information on the effects of carbaryl on ants. The immediate effects of insecticides on aquatic insects were documented in the sections dealing with quality control and contingency monitoring.

The recovery of aquatic insects was a special concern because they are important as fish food and perform numerous other functions for energy transfer in the aquatic system. Recovery of aquatic insects will be addressed for 1982 treatment areas, 1983 treatment areas, and the Willow Creek spill. Monitoring of some of these areas will continue into 1984.

1. Recovery of Aquatic Insects from Insecticide Application

a. 1982 Application Monitoring Sites - One Year Recovery

Changes in aquatic insect populations, presence of insecticide in water samples and field observation indicated five streams were hit with insecticide drift or spray in 1982 (Table 8 and Appendices D and N). Concentrations of carbaryl in composite water samples in these streams ranged from a trace to 81.0 ppb. Mayflies, stoneflies, and caddisflies, the most sensitive orders, had post spray increase factors in the aquatic drift ranging from 1.1 to 4.8 times that of prespray samples. Deep Creek, which was observed being oversprayed for several miles, had an "estimated" increase in insect drift of 50 to 100.

Post spray benthic sampling showed decrease factors in sensitive species ranging from 0.4 to 3.8. Reductions of benthic insects in Deep Creek were large. All other changes in benthic or drift insects on the other streams were medium or below. Reynolds Creek showed a slight increase in post spray benthic insects despite being hit by carbaryl. Lower Big Boulder Creek was not effected by the carbaryl at the time the 1982 post spray sample was taken; however, records indicate some upstream reaches were hit with carbaryl at a later date in 1982.

During the 1983 WSBW Project, the benthic communities of these streams were again sampled at approximately the same locations and times (Table 8). In four of the five streams both the total numbers of all aquatic insects sampled and the total number of insects within sensitive orders exceeded

Table 8. Recovery of Aquatic Insects in Five Streams One Year After the 1982 Western Spruce Budworm Project.

Stream (Composite Water Sample ppb Carbaryl)	Type Sample	Collection Date	Aquatic Insects by Order 1/ EPH	PLE	TRI	COL	DIP	Subtotal (EPH+PLE+TRI)	Total	Benthic Decrease or Drift Increase Factor	Relative Change for Subtotal 2/
Deep (81.0 ppb)	pre benthic	6/24/82	114	15	9	48	30	138	216		
	post benthic	6/25/82	24	0	12	42	27	36	105	3.8	High
	post benthic	7/05/83	198	10(2)*	32	56	342	240	638	0.6	None
	pre drift	Not collected									
	post drift	6/24/82	61,080	17,000	6,720	440	8,160	84,800	93,400	50-100 (estimate)	High
Deardorff (1.0 ppb)	pre benthic	7/1/82	330	18	60	104	234	408	746		
	post benthic	7/4/82	198	69	42	81	99	309	489	1.3	None
	post benthic	7/3/83	120	68(6)*	56	42	42	244	328	1.7	Low
	pre drift	6/29/82	156	36	12	32	140	204	376		
	post drift	7/3/82	824	32	56	40	856	912	1,818	4.8	Medium
Lick (8.6 ppb)	pre benthic	6/26/82	105	15	18	24	54	138	216		
	post benthic	6/28/82	66	15	9	15	66	90	171	1.5	Low
	post benthic	7/5/83	242	72(6)*	74	102	280	388	770	0.4	None
	pre drift	6/26/82	112	0	16	28	30	128	192		
	post drift	6/27/82	148	8	44	28	140	200	384	1.6	Low
Reynolds (1.1 ppb)	pre benthic	6/29/82	261	75	36	69	36	372	477		
	post benthic	7/6/82	288	84	27	135	117	399	651	0.9	None
	post benthic	7/3/83	292	56(4)*	50	80	136	398	614	0.9	None
	pre drift	6/28/82	212	24	24	28	76	260	340		
	post drift	7/4/82	448	72	72	80	160	602	836	2.3	Low
Big Boulder, Lower (Trace)	pre benthic	6/25/82	42	51	15	0	12	108	120		
	post benthic	7/1/82**	156	63	54	12	54	273	339	0.4	None
	post benthic	7/5/83	76	16(7)*	21	14	87	113	214	1.0	None
	pre drift	6/24/82	168	4	12	8	40	184	232		
	post drift	6/30/82	156	4	36	8	56	196	260	1.1	None

* Taxons present in parenthesis

** Up stream tributary hit with spray on 7/6/82. Some down stream aquatic insect kill may have occured at this site after the sample date.

1/ EPH - Ephemoptera, PLE - Plecoptera, TRI - Trichoptera, COL - Coleoptera, DIP - Diptera

2/ Explaination of heading can be found in Table 1.

those found in 1982 prespray samples.

Water samples indicate Deep Creek was "hardest" hit with insecticide in 1982. One year post spray samples contained more total and sensitive aquatic insects then 1982 prespray samples. Deardorff Creek received a "light" insecticide hit in 1982; however, it contained fewer aquatic insects in 1983 then in 1982.

The analysis of the most sensitive order, plecoptera, one year after overspray found a range of two to seven taxons present in these streams (Table 8 and Appendix D, Table 3). Deep Creek which received the greatest carbaryl concentration only contained two taxons in 1983. One taxon, chloroperlinae was present in four of the five streams in relatively large numbers, but was not found in Deep Creek. This information on stoneflies suggests slower recovery of this order in streams that are heavily sprayed with chemicals and agrees with previous reports in the literature.

It appears that aquatic insect communities in streams hit with spray on drift in 1982 are recovering. Total numbers of aquatic insects often exceeded those present in prespray samples; however, aquatic insect communities are probably not as diverse as they were prior to being hit with spray. Full recovery of these insect communities requires over one year.

b. 1983 Application Monitoring Sites - Three Month Recovery

Short-term recoveries of aquatic insect communities in streams hit with spray during 1983 were monitored. About three months after Bully, Lane, Indian, Cat, Alder, and Cottonwood Creeks were sprayed, benthic samples were again taken in close proximity to the original site. Data from previous sampling were also summarized for these streams to obtain a relative idea of the numbers and kinds of aquatic insects present before overspray occurred (Table 9, 10, and Appendix D).

The following interpretations are made from the information collected on the short term recovery of aquatic insect populations (Tables 9 and 10):

Cottonwood, Cat, and Alder Creeks - all received heavy concentrations of carbaryl due to direct overflight during application.

(1) Mayflies and true flies have rapidly recolonized these streams. Five taxons of mayflies were present in the three streams. One family of mayflies, Empherellidae, was found in all streams and made up 38% to 93% of the individuals. In a similar fashion, one family of true flies, Chironomidae, was found in all streams and made up 23% to 92% of the individuals. The family Tipulidae (crane flies) was also present in all streams but in much lower percentages.

(2) Stoneflies and caddisflies were not as quick to return. There were only two taxons of stoneflies present with the taxon Chloroperlinae representing 25 of the 26 stoneflies found. Four taxons of caddisfly were present in the three streams with no stream having more than two caddisfly taxons.

Table 9. Short Term Recoveries of Aquatic Insect Benthic Populations in Some Carbaryl Affected Streams for the 1983 WSBW Project.

Stream	B = Before A = After Treatment	Collection Date	Number of Insects by Order 1/ EPH	PLE	TRI	COL	DIP	Subtotal 2/	Total
Alder*	A	7/10/83	63	19	9	5	2	91	98
	A	9/29/83	1242	25	22	0	287	1288	1575
Bully**	B	6/25/83	127	10	10	9	26	147	182
	A	10/1/83	171	1	607	663	336	779	1778
Cat*	A	7/10/83	3	34	1	0	3	38	41
	A	9/29/83	1298	0	8	0	63	1306	1369
Cottonwood	B	6/29/83	176	56	150	140	302	382	824
	A	7/9/83	61	16	71	61	61	148	270
	A	9/28/83	334	2	84	86	517	420	1023
Indian**	B	6/23/83	37	23	51	29	60	111	200
	A	10/1/83	216	80	240	88	208	536	832
Lane	B	6/27/83	146	62	110	24	166	318	508
	A	7/5/83	90	6	38	66	296	134	496
	A	10/1/83	255	4	919	33	268	1178	1599

* Before treatment sample not taken.
** Initial after treatment sample lost.
1/ EPH = Ephemoptera, PLE = Plecoptera, TRI = Tricoptera, COL = Coleoptera, DIP = Diptera
2/ EPH+PLE+TRI

Table 10. Short Term Recoveries of Aquatic Insects from Benthic Samples in Streams Sprayed with Carbaryl Using Taxons Per Order as an Index, 1983.

STREAM	COLLECTION DATES	Taxons Per Order EPH	PLE	TRI	DIP
Bully	6-25	--	4	--	--
Bully	10-01	--	1	--	--
Lane	6-27	--	7	--	--
Lane	7-05	--	2	--	--
Lane	10-1	--	2	--	--
Cat	7-08	--	3*	--	--
Cat	9-29	4	0	3	4
Alder	7-07	--	2*	--	--
Alder	9-29	3	2	1	4
Cotton-wood	6-28	--	2	--	--
Cotton-wood	9-29	3	1	3	3

* An estimate derived from drift samples
-- Samples were analyzed only to order

(3) Although the numbers of aquatic insects present are very high, the taxons present are probably much lower than in prespray conditions.

Lane, Bully, and Indian Creeks

(1) Although the post spray numbers of aquatic insects (except stoneflies) present in these streams by order is very high, the taxons present in each order are probably very low (Tables 9 and 10). The Bully and Lane Creek samples together contained only 5 stoneflies consisting of two taxons (Appendix D - Table 3). Both streams received heavy concentrations of carbaryl.

(2) The numbers of aquatic insects present in Indian Creek by order is very high. This creek appears to have received lesser amounts of carbaryl than Lane or Bully Creeks; however, no data on diversity within orders was collected.

2. Recovery of Aquatic Insects from Insecticide Spill

Effects of the Willow Creek spill were documented in the Contingency Monitoring section. Essentially all aquatic insects were killed in 21 miles of stream. Peak concentrations of carbaryl ranged from about 40 ppm (approximate solubility level in water) for the first six miles to 9 ppm near the Heppner Reservoir 21 miles downstream. A few insect species which are able to get out of or live on top the water surface were able to survive.

Taxon Aquatic Monitoring Service accomplished some followup monitoring about 3½ months following the spill. Results of the data collection is presented in Appendix I and Table 11. Numbers and types of aquatic insects were still drastically affected for the upper reaches of Willow Creek below the spill site.

An estimate of recovery of insect diversity is presented in Table 12. Willow Creek above the reservoir was noticeably affected when numbers of families are compared with uneffected tributary streams. Diptera were able to rapidly recolonize. Individuals from the Chironomidae (midges) and Simulidae (black flies) families were numerous. We assume normal predators were eliminated or reduced allowing unusually high populations to occur. The apparent recovery ability of the common families of aquatic insects is presented in Table 13.

Certain taxons of aquatic insects rapidly recolonized the stream with large numbers of individuals. Other types of insects, especially stoneflies, were less able to respond. This low recovery may be due to their longer life cycles, temporary changes in habitat (excessive algae production because grazers were reduced) or their eggs may have been more sensitive to carbaryl. Further monitoring is being conducted in a cooperative effort as mentioned earlier.

A review of the data for the Cow Creek overspray and spill (Appendix D, Table 6) indicates similar recoveries by order and family after 3 months as that exhibited by Willow Creek (Table 13). A similar recovery pattern is also evident in Cottonwood, Alder, and Cat Creeks 3 months after being oversprayed.

Table 11: Willow Creek Aquatic Insect Recovery Survey Frequency Information by Sample Site (09-30-83) 1/

AQUATIC INSECT Order	Family	1. Willow Cr. above spill	2. Herren Cr.	3. Willow Cr. nr Yocum Cabin	4. Willow Cr. 5.8 mi. below spill	5. Willow Cr. above N. Fork	6. N. Fork Willow Creek	7. Willow Cr. below N. Fork	8. Willow Cr. above Skinners Fork	9. Skinners Fork	10. Willow Cr. below Skinners Fork	11. Balm Creek	12. Hinton Creek	13. Willow Cr. 1.5 mi. N. of Heppner	14. Willow Cr. above Rhea Cr.	15. Willow Cr. below Rhea Cr.	16. Rhea Creek
EPHEMOPTERA	Baetidae	144	64	64	256	80	368	244	472	272	320	320	448	1488	64	240	232
	Heptageniidae	4	192				304	36		16							
	Ephemerellidae	8	400		192	96		16	48		80	48	48	88			
	Leptophlibiidae	8	392				48	8		400			32	336			
	Tricorythidae														28		16
PLECOPTERA	Pteronarcidae									32							
	Nemouridae	36	184				160			256			16	16	4	64	8
	Capniidae	8	288				48					16					
	Perlidae						16										
	Perlodidae	4	32		128	112	272	120	120	112		32					
	Chloroperlidae						160										
TRICHOPTERA	Hydropsychidae		16			128	64	148	328	1372	128	1520	512	1648	748	2416	4320
	Glossosomatidae		144							32							
	Hydroptilidae								8			16					
	Brachycentridae		8														16
	Lepidostomatidae		8														
	Limnephilidae	4	8					12		16							
COLEOPTERA	Elmidae	4	48	8	16	16	256	48	152	384	128	48	48	96	48	32	208
DIPTERA	Heleidae																16
	Tipulidae	12	96		64	16	48	40	80	80	32		16				
	Chironomidae	188	368	296	1328	816	384	128	3288	336	2112	208	400	336	604	2336	840
	Simulidae		8	168	1152	1392	16	572	1128		160	96	16	40			40
	Stratiomyidae									16							
	Empididae				16			8	8							16	
TOTAL		420	2256	536	3152	2656	2144	1380	5632	3328	2960	2304	1536	4048	1496	5104	5696

1/ Review enclosed maps for sampling site locations. Sampling area was 3-1 square foot benthic samples. Subsample size was 1/4, 1/8, or 1/16 depending on insect numbers. The Willow Creek spill occurred on June 13, 1983. Collected by Taxon.

Table 12: Recovery of Aquatic Insect Diversity in Willow Creek Using Number of Families as an Index to Compare Effected and Uneffected Streams.

Monitoring Site	Willow Creek River Mile 1/ or Mileage of confluence of Tributary	Number of Familes by Order EPH	PLE	TRI	COL	DIP	Subtotal (EPH+PLE+TRI)	Total
EFFECTED STREAMS								
Willow Cr. near Yocum Cabin	75.0	1	0	0	1	2	1	4
Willow Cr.	72.4	2	1	0	1	4	3	8
Willow above N. Fork	69.8	2	1	1	1	3	4	8
Willow below N. Fork	69.1	4	1	2	1	4	7	12
Willow above Skinners Fork	64.6	2	1	2	1	4	5	10
Willow below Skinners Fork	64.1	2	0	1	1	3	3	7
Willow below Reservoir	54.3	3	1	1	1	2	5	8
Willow above Rhea Cr.	37.9	2	1	1	1	1	4	6
Willow below Rhea Cr.	37.2	1	1	1	1	2	3	6
UNEFFECTED STREAMS								
Willow Cr. above spill	78.6	4	3	1	1	2	8	11
Herren Cr.	77.0	4	3	5	1	3	12	16
N. Fork Willow Cr.	69.4	3	5	1	1	3	9	13
Skinners Fork	64.3	3	3	3	1	3	9	13
Balm Cr.	57.3	2	2	2	1	2	6	9
Hinton Cr.	55.2	3	1	1	1	3	5	9
Rhea Cr.	37.7	2	1	2	1	3	5	9

1/ The spill occurred at River Mile 78.2

Table 13: Short Term Recovery Abilities for Common Aquatic Insect Families in Willow Creek.

Order	Recovery Ability by Family		
	Low	Medium	High
EPH	Heptageniidae Leptophlibiidae	Ephemerellidae	Baetidae
PLE	Nemouridae Capniidae	Perlodidae	
TRI			Hydropsychidae
COL		Elmidae	
DIP		Tipulidae	Chironomidae Simulidae

B. Terrestrial Vertebrate Species

No terrestrial vertebrates were monitored by project personnel in 1982 or 1983; however, Dennis Van Horn, Malheur N.F., collected information on changes in bird populations in 1983. This data is tentatively scheduled for presentation at the Oregon Chapter of the Wildlife Society Annual Meeting at Newport, Oregon in February 1984.

Although we did no formal monitoring of terrestrial vertebrates, the following observations were made:

1. No mortality or unusual behavioral patterns of animals were seen on sprayed areas during field work. Other studies indicate brain cholinesterase levels are lowered when carbaryl is ingested by vertebrate animals; however, the action is reversible. The amounts of carbaryl or mexcarbate sprayed per acre would seldom be expected to cause direct mortality to terrestrial vertebrates from consumption of contaminated food or contact with contaminated folage, water, etc. or direct application.

2. Rapid and significant decreases in nearly all terrestrial insects populations occurred from the spray application. Insectivorous vertebrates, i.e., many bird species (especially young birds), shrews, bats, moles... probably experienced marked reductions in available food supplies. The literature which concentrates on birds indicates a range of effects from no apparent changes to marked reductions in bird numbers. Since similar pesticides were used in the 1983 project as in these reports, similiar effects could be expected within sprayed areas.

3. Within or adjacent to each Entomological Unit there were areas that were not sprayed for a variety of reasons:

Non-host types - meadows, ponderosa pine stands,... did not contain budworms in large numbers.

Buffers - water bodies or streams, identified critical areas (eagle nests, domestic water supplies...)

Error - portions of host areas within spray blocks were not sprayed.

Therefore, not all of a Entomological Unit, or spray block was covered by spray and these unsprayed areas were defacto refuges for both insects and other species.

4. Increased, but unintentional, harassment of wildlife species resulted from project personnel and activities. Some activities resulted in the direct death of animals, i.e., animal/vehicle collisions. While catastrophic to the individual animal, these deaths probably had little effect on populations. Project personnel in the woods, aircraft, and vehicles driven on roads significantly increased the harassment of many animals. Abandonment of nests by birds, and reductions in resting and feeding opportunities of many other species were possible negative factors. We have no measure of the extent of these negative effects.

C. Aquatic Vertebrate Species

1. Overspray Effect on Fish

A number of streams were hit by various amounts of spray. On Cow, Cat, Alder, and Cottonwood Creeks water samples for insecticide analysis were taken and intensive field observations made within two to four hours following spray application. At least one and often two or three repeat visits were made to these streams in the following week. In most cases a visit was made the day after spray application. Water samples had carbaryl concentrations as high as 53 ppb in Cat Creek.

a. Direct Effects On Fish

Neither Bill Hansen or Gene Silovsky observed any dead or distressed fish in any of the streams hit with spray. Rainbow trout, dace, suckers, chubs, and lampreys or various combinations of these were present in these streams. Live and apparently "normally active" fish were seen in these same streams several hours to seven days after the spray application.

Numerous other sites were sampled using aquatic drift nets and no unusual numbers of fish were caught in the nets. Occasionally live fish fry were found in both pre and post treatment drift net samples.

b. Indirect Effects On Fish

The rapid and significant reductions in aquatic insect numbers in streams hit with spray are assumed to cause a comparable reduction in the food supply available to fish. The diets of fish in the project area are made up almost entirely of insects, predominately aquatic insects. The greatest adverse effect could be expected on the younger age class, i.e., fry and year class 1 fish. A temporary reduction in the carrying capacity of streams hit with insecticide was expected. The duration and extent to which the carrying capacity is reduced is not known.

A long term (2-5 year) monitoring program is needed to answer questions concerning carrying capacity. Some of the more obvious facets include:

1. How well can fish substitute terrestrial insects for aquatic insects, especially since they were also reduced by the insecticide?

2. If the aquatic insect community recovers to pre spray levels is there a time lag for fish population recovery?

3. Is the aquatic insect community's return (in both numbers and kinds of insects) to pre spray levels the best indicator that the stream's carrying capacity is also recovered?

4. Are fish able to utilize the high numbers of the few aquatic insect species that recolonize a stream after overspray?

Some of these questions may be answered by the Willow Creek followup monitoring.

VI. ENVIRONMENTAL MONITORING RECOMMENDATIONS FOR FUTURE PROJECTS

Populations of Western Spruce Budworm in Oregon and Washington have locally reached epidemic proportions frequently in the past 35 years. Generally, aerial applications of chemical insecticides were used to suppress these epidemics. We assume these population eruptions and chemical supression efforts will continue with similar frequency in the future. Based on these assumptions and our monitoring experiences during the 1983 project we recommend there be two separate monitoring efforts.

1. Short term quality control monitoring for each spray project. The major objective would be to insure environmental mitigating measures, requirements and constraints are applied with a high degree of success. We assume that the same or more stringent mitigating requirements and constraints will apply to future spray projects (i.e. prevent chemical from reaching waterbodies, streams, key habitat areas...). To meet the major objective, monitoring should provide a more immediate indication on the degree of success or failure. This would allow project personnel to make corrections and increase the overall success of the project.

We recommend the following procedures be used:

a. Well in advance of the arrival of spray ships, map and field mark all key areas requiring buffers or other types of protection from spray.

b. Use spray card lines to sample the success of buffers. There should be an adequate number of these card lines so a representative sample can be obtained. These cards could be placed and retreived by crews which monitor the application as well as those monitoring water. Card lines should be picked up and read within 6 hours after spray application.

c. Supplement spray card lines with field observations of stream reaches to determine success of buffers.

d. If it is evident from b or c that spray reached a stream then (1) Water samples should be taken at appropriate locations. (2) Aquatic insect collections made to document changes in populations; (3) The length of the stream effected and the amount of aquatic insect kill determined; (4) Project personnel should determine what went wrong, identify corrective measures, and notify field and application personnel of necessary changes.

e. Fluorescent dye should be evaluated for increased use as a tracer of the insecticide that will be applied. Water sampling can then be done with the ability to provide a more immediate indication of the effectiveness of buffers.

f. Language in the contract needs to provide direction for implementing changes when monitoring indicates insecticide applications is not adequately meeting the mitigating requirements or constraints. Appropriate project personnel must have the authority to make these changes.

g. Aquatic insect sampling used in this study could be continued to sample the overall effectiveness of protecting streams; however, it requires large amounts of time in collecting and analyzing data. The taxomomic work required does not provide an immediate indication of the extent and type of aquatic insect mortality. Aquatic insect sampling maybe best used to identify the extent of changes in aquatic insects after a stream is sprayed as determined by procedures identified in Items b, c, or e.

If aquatic insect sampling is used then we have the following recommendation and observations.

- Aquatic insects are very sensitive to insecticidies entering the stream environment.

- Drift insect sampling provides an "immediate indication" of insecticide entry into streams when the application is heavy.

- It is not possible to get immediate readout on insecticide entry into the stream from benthic samples; however, benthic samples do not have to be taken the morning of spray application and several days of treatment in a watershed can be sampled inexpensively. At least 3 one square foot samples need to be composited to decrease sampling error.

- Pre and post sampling should be done by the same person in the "same" locations.

-Analysis of aquatic insects to the lowest taxonomic level provides valuable information on diversity, especially in benthic samples.

2. Evaluation of long-term effects for selected non-target species. The major objective would be to evaluate changes in populations of non-target indicator species or groups where food supplies are altered significantly by spraying. By long-term we mean 2 to 5 years.

We recommend the following procedures be used to establish this monitoring program.

a. A compilation, review, and summary of pertinent studies on the effects of carbaryl and similar chemicals needs to be made. This would provide a concise body of information for all user groups. Additionally it should point out areas in which monitoring needs to be focused and where duplication of effort is not needed.

b. An interagency task force of biologists, in both research and management should help develop the long-term monitoring plans. These plans should be designed to answer specific pragmatic questions.

3. The lead agencies for the spray projects should provide the long-term multi-year funding necessary.

Some of these long-term monitoring projects on stream systems, i.e. Willow Creek, are currently under development.

V. SUMMARY

The findings and interpretations found in this monitoring effort are capsulized in a similar order as presented in the body of the report.

A. Quality Control Monitoring

Aquatic Insects were the best indicators of the project's success in keeping insecticides out of streams. These insects are sensitive to stream contamination and are constantly "sampling" the water. Effects of insecticides on aquatic insects included changes in behavior at low concentrations or mortality at higher concentrations (Appendix G).

Table 14 summarizes the Quality Control Monitoring information on streams using changes in aquatic insect populations and spray card records. The data indicates 33% of the stream sites were effectively buffered and another 23% only received slight or low levels of spray. Significant amounts of spray reached 45% of the sites. Data from both aquatic insect monitoring and spray cards were similar.

Other methods used in quality control monitoring included water analysis for insecticides or tracer dyes and field observations. Water analysis requires substantial expertise, equipment, and money to obtain meaningful results. Observations from walking stream sections are extremely valuable. A combination of available continues to be the most desirable.

Table 14. Summary of Quality Control Monitoring Site Information on Extent of Aquatic Insect Change From 1983 Insecticide Application for the Western Spruce Budworm Suppression Project.

Type of Monitoring	Number of Sites	Relative Extent of Change 1/ (% of total number by category) None	Low	Medium	Medium-High	High
Aquatic Insect Changes						
Primary Sites	20	30	10	25	15	20
Secondary Sites	34	35	24	9	6	26
Spray Deposit Cards						
Placed	17	29	29	35	0	6
Chance	34	32	26	15	15	12
TOTAL	103					
Weighted Averages (% by category)		33	23	18	10	17

1/ Relative extent of change deals with the subjective rating of information from Tables 1, 2, 3, 7, and 8.

B. Contingency Monitoring

Several insecticide spills were monitored to various degrees. Large spills like the Willow Creek spill (3,800 lb. carbaryl) have the following effects:

1. Mortality on all aquatic vertebrates restricted to the stream until concentrations are contained, sorption occurs, or dilution is to non-toxic levels.

2. Mortality of all aquatic insect life restricted to the water until substantial change in concentration has occurred. Some insects will likely be effected until a large body of water or river is reached to promote dilution. Extent of direct impacts to invertebrate populations is much larger than vertebrates.

3. Diesel smell or sheen may be seen at higher concentrations of chemical in the water.

4. Change in stream clarity (turbidity) noticeable for higher concentrations of insecticides which have latex in the mix.

5. Large numbers of excited people will be wandering up and down the roads near the stream, waving their arms, collecting information, trying to provide meaningful assistance...

Small spills will have only limited, if any, effect on fish mortality but likely will cause substantial effects to aquatic insect life. The loss of food will indirectly influence the condition of the fish. Timing of the spill may be critical to fish if sufficient time for insect recovery is not available before environmental conditions as stream temperature change.

C. Non-Target Species Monitoring

Aquatic insects rapidly repopulate streams after insecticide overspray. Total number may even exceed those present prior to oversprays in just a few months; however, a few taxons make up a large percentage of the total numbers. Streams likely do not return to pre spray species diversity one year after overspray. The effect from large spills indicate longer recovery time especially for the most sensitive species. A better understanding of insect life cycles would be helpful in estimating recovery ability. Drifting insects from non-effected stream reaches help to promote recovery from oversprays or spills.

Insectivorous terrestrial vertebrate species may be affected from insecticide applications due to change in food supply and temporary effects in brain cholineresterase level. Direct mortality from insecticide applications is unlikely, but indirect effects could cause a lower condition factor of animal or movement (if possible) from treated areas.

Fish (aquatic vertebrates) likely experience greater effects than terrestrials from insecticide application or spills because they are more confined and the chemical in the stream cannot be avoided. Concentrations of insecticides from substantial spills like Willow Creek cause direct fish mortality. Normal effects from insecticide overspray include a reduction in food supply and a decrease in condition factor. The extent and duration of these losses are not known.

APPENDICES

APPENDIX A

MONITORING PLAN FOR THE WESTERN SPRUCE BUDWORM PROJECT IN NORTHEASTERN OREGON

I. PROJECT PLANNING

Monitoring following application of insecticides is necessary to (1) compare stream concentrations with water quality criteria (Appendix G), (2) meet requirements of the environmental assessment, and (3) evaluate the application methods and safeguards. In many cases, monitoring may be implemented in direct response to issues or concerns voiced in the environmental assessment or as identified by appropriate state, federal, or research specialists. Information collected during monitoring efforts will be utilized to modify and improve application methods and safeguards (best management practices).

A. PRIORITY ANALYSIS

Direct water usage and its proximity to the treatment area is the primary factor used in determining monitoring needs. Priority monitoring (type and extent) will be given to the following uses:

1. Municipal supply. (Community water systems)
2. Domestic supply. (Public water systems)
3. Fish hatchery or chinook bearing stream.
4. Stream with active fish studies or evaluation.
5. Important fish rearing and spawning streams.
6. Important streams or lakes used in water contact recreation.
7. Socially sensitive areas.
8. Other sensitive ecosystems or non-target organisms.

Distance from treatment area to the beneficial use is also given heavy consideration. Computations made using potential contamination assumptions of worst case application methods may be used in determining monitoring needs (Appendix A). Enough water monitoring should be accomplished to assure the Forest Service, BLM, State, the general public, and regulatory agencies that the insecticide application is adequately protecting water quality and fish habitat.

B. PROJECT MONITORING LEVEL

Several monitoring levels may be necessary to accomplish "quality control" as well as "use protection" objectives. Four types of monitoring are included in the following discussion: (1) Quality Control (2) Use Protection, (3) Contingency, and (4) Non-Target Organism Monitoring.

1. Quality Control Monitoring

The objective is to determine if insecticide application met the project quality control expectations. Collected information will be used to evaluate or modify controls and standards for future projects. Substantial variation in available methods is allowable to meet this level of monitoring. Most of the

water monitoring will be of this type. The following methods are considered acceptable:

a. Spray Deposit Cards - placement of cards adjacent to the stream and various distances from the stream will be helpful to evaluate the effectiveness of the buffer in reducing drift. This method is possibly more useful in determining whether or not insecticide has reached the stream. Placement of cards at 50-100 feet intervals along a stream section is adequate to determine if spray application is successful in minimizing or keeping insecticide out of the stream. This method can be extremely valuable as sampling tool in sensitive stream buffer areas. Spray cards will generally not be useful in determining stream concentrations. If cards indicate that significant drift reached the stream, additional sampling should be implemented. Rhodamine Base BT or other dye may be useful in the spray mixture because any drift clearly shows up on the spray cards, foliage, and other surfaces. Oil sensitive cards may also be used if the chemical is oil based. Several cards placed in the treatment area can also be used as a comparative index.

b. Dye Tracer - fluorescent tracer dye is added to the insecticide mixture and acts as an indicator of possible contamination in water samples. The normal mixing ratio is 50 parts insecticide to 1 part Rhodamine Base BT dye to detect at least 5 ppb insecticide. (Calculation example Appendix B.) (Dye is expecially being considered for the Pogue Pt. 2 area to be treated with Zectran. Dye costs would be minor at approximately 5-7 cents per acre.)

   Stream travel time will be estimated or measured for proper sampling duration. Quality control monitoring allows use of automatic sampling devices to collect samples for dye analysis. Samples will be analyzed within one day and must be kept out of direct sunlight.

c. Laboratory Analysis - an individual or composite grab sample will be analyzed for insecticide residue by a State or EPA certified laboratory for pesticide analysis. The sample sent for analysis will represent the period most likely to be contaminated (probable maximum concentration) as determined or estimated by the time of travel. Water sampling during or following storm events may be necessary to insure maintenance of water quality.

d. Aquatic Insect Monitoring - drift of aquatic insects will be monitored as the primary indicator of acceptable water quality. Aquatic insect drift is very sensitive to direct application of insecticide. Drift sampling will be either done on a 24-hour basis (emptying at 6 hour intervals) or a grab sample basis

where stream travel time is the main consideration. Water sampling will be initiated for all sites where noticeable drift is occurring. Any project personnel that notice aquatic insect kills should report their findings and location immediately to the Environmental Coordinator or Assistant, and the Project Director or Heliport Manager.

Prespray and postspray insect drift sampling will try to include information on diurnal drift patterns. Control stations may be used to reduce variability. Streams with marked noticeable changes may have one or more water samples analyzed to document insecticide concentration. Aquatic insects will be enumerated by order unless specifically changed. Large insect numbers will be representatively sampled before identifying individuals to order and enumerating. Sampling will be accomplished as much as possible in a stream riffle section with uniform bottom and surface water conditions. (Sections with unusual turbulance or standing waves should be avoided if possible. Flagging or other markers will aid in locating samples in the same area for Postspray evaluations.)

e. Benthic Sampling - Collection of aquatic invertebrates living in the channel substrate will be used as an indicator of the presence of a viable aquatic population where streams have been impacted with insecticide application. Primary concern is that aquatic insect populations (especially Plecoptera) do not easily repopulate affected reaches. Streams impacted from the 1982 application include Deep Creek (mandatory site), Reynolds Creek, Deardorff Creek, Lick Creek, and Upper Big Boulder Creek. Site locations for the 1983 evaluation will not be known until after treatment. Drift nets may be set up in conjunction to estimate the presence or absence of aquatic drift from upstream. Selected streams will be sampled with at least 3 benthic samples (utilizing a modified Hess or other suitable sampler) which will be composited and then enumerated and ordered.

f. Visual Monitoring - Aerial and land based observers will be utilized to help provide adequate stream protection from insecticide drift. Weather conditions which may cause excessive drift will also be monitored to ensure proper application. Observers will be in contact with the helicopter pilots and notify them if adjustments in application are necessary to properly buffer water. The water monitors will be kept informed of progress and conditions as appropriate.

While any of these methods may be useful in quality control monitoring, additional work to combine several of these methods may result in a more meaningful approach to meet site specific needs.

2. Use Protection Monitoring

Use protection monitoring requires a higher level of monitoring and will be conducted in areas where very sensitive downstream water uses occur (primarily municipal or community water systems). This level of monitoring may be needed to provide notification to downstream users of the contaminant level or to assure that water quality was maintained. The greatest potential for damage exists under an accidental spill. In this low probability event, intensive warning, cleanup, and monitoring operations are initiated. No streams have been identified which require this level of monitoring in 1983. Treatment area in the Desolation Creek watershed, is not sufficient to warrant this level of monitoring. Some quality control monitoring is being planned.

Tracer dye is often a requirement for use protection monitoring. Analysis of samples must be timely to provide an "early warning" when necessary and possible to alert downstream users of potential or actual contamination exceeding allowable limits. All detectable dye (estimated insecticide at 5 ppb or greater at the downstream use) will be reported to the Project Director or assistant. Stream time of travel information is required under this monitoring level. This data may be obtained using salt additions and a conductivity meter. Following the prespray sample, the water sampling schedule will concentrate on periods where time of travel information indicates potential contamination would be reaching the monitoring site.

Followup water samples after 24 hours and also during the first significant runoff producing storm(s) may also be taken on these priority areas. Conditions which may signal additional monitoring include dye residue found in water samples, storm timing and intensity, and unusually sensitive downstream use. The Monitoring Coordinator will be responsible to determine need and coordinate with others as necessary. To reduce analysis costs, water samples will be composited where possible. Other methods and tools listed under quality control monitoring may be also utilized at this level as needed. Aquatic insect drift will still remain an indicator which will be monitored. It may be necessary to service drift nets at more frequent intervals than mentioned in the aquatic insect section.

3. Contingency Monitoring

Intensive monitoring will be required if an accidental spill occurs or concentrations exceed anticipated values. Objectives of this monitoring include documentation of spill concentrations at the preselected monitoring site(s), at backup stations downstream, and at nearest known use(s). Contingency monitoring will be activated and the lead monitor notified immediately if (a) spilled insecticide reaches, or has a strong potential for reaching a stream; (b) tracer dyes indicate 40 ppb insecticide is likely present. (If tracer dye was not used in the spray mixture, dye additions at the spill site maybe useful to determine travel time and predict dilution rates); (c) a visible oil sheen can be seen on the water. (d) substantial increase in aquatic insect drift; (e) Spray cards indicate heavy concentrations reached the stream. Downstream knowledge of tributary inflow is also

essential to this determination. Other monitoring efforts may be temporarily abandoned to accomplish this monitoring.

The following is a brief list of considerations should contingency monitoring be initiated.

(a) Obtain sampling containers. Upwards of 50 containers may be needed. Clean glass bottles should be used if sampling containers are not available.

(b) Estimate when the spill first entered the water and distance it may have traveled during the intervening time. Estimate when spilled material will reach point of concern downstream.

(c) Select sampling points and collect samples to measure peak concentration and duration of contamination. Sampling will be more frequent during expected peak concentrations, but sampling therafter should be a 1-3 hour intervals depending on magnitude of spill and contamination curve. Sampling will continue for at least 24 hours after the spill. Samples will be properly preserved, stored, and carefully handled. Labeling and "chain of custody" are critical due to the legal ramifications.

(d) Submit individual or composite samples to an approved laboratory for priority analysis with arrangement to receive test results as soon as possible.

(e) If any fish are harmed, collect specimens of dead or distressed fish, aquatic insects, or other aquatic organisms as noticed and properly label and preserve samples. Timely analyses are important.

(f) Photo documentation can also be quite important relative to site conditions, sampling stations, intakes, personnel onsite, etc. Monitoring should be included in contingency guides and the Spill Plan.

4. Non-Target Organism Monitoring

The objective is to document noticable changes in non-target organism behavior, populations, or growth from chemical applications under normal application (non-spill) conditions. This monitoring priority may be lower than other types due to difficulty in carrying out meaningful studies and much research has already been accomplished in attempts to answer the concerns relative to impacts on non-target organisms.

Primary effort will be made to investigate and document complaints concerning honey bee kills. Bees could be sensitive to direct application and indirect affects from bringing back recently contaminated pollen.

Insecticide influence to fisheries is of prime concern. Information collected by the Oregon Dept. of Fish and Wildlife or others may be utilized on study streams (eg. Summit Cr., Murderers Cr., Deer Cr., Clear Cr.) to evaluate changes in fish population or size. It is doubtful that analysis of these results would be available for the 1983 program evaluation. Analysis of information

collected by others may be accomplished with the 1984 application monitoring program. If aquatics are impacted within a study drainage as evidenced by changes in aquatic drift or benthic populations, necessary efforts should be made to evaluate impacts retrievable from existing and future data collections. Typically, project monitoring would not enable collection of detailed fishery information as can be found on Fish Study streams. Differences in fish production should be compared for pre and post treatment with insecticides within treated and control watersheds.

Other streams where substantial increases in aquatic insect drift occur may be evaluated for possible information collection. Study examples of the following types may be useful in particular situations:

1. Immediate documentation of fish species size, and population numbers and carrying capacity of stream before effects of changes in food supply. Follow-up measurements to assess changes (short and long term).

2. Collection of benthic insect samples over a period of time to document changes in population composition and/or re-establishment rates. (May want to key into plecoptera changes due to their sensitivity and importance in the food chain for leaf processing). Collection of benthic information from several streams treated in 1982 is an attempt to look into these changes.

3. Collection of aquatic insect drift samples over a period of time to determine the return rate of sensitive organisms (eg. Plecoptera) may be helpful in the assessment of long-term impacts. A look at drift in several streams treated in 1982 may provide some clue to long term influences.

Information may be collected on other organisms which have been influenced by direct application or indirect effects such as consuming treated insects or being stressed by lack of food supply. Treatment areas where bird or other wildlife populations have been evaluated (study area) or are of particular concern would receive a higher priority. Some information in 1983 may be collected on gallanaceous birds (eg. grouse) because they typically feed on insects as spruce budworm larvae and they are game birds.

Analysis relative to direct effects from the chemical on non-target organisims would be for suppression of brain cholinesterase activity Indirect effects may be evaluated in organism numbers, size, habitat, or behavioral changes.

Because much of the long-term, indirect affects are extremely complicated and difficult to measure, it is doubtful that the project monitoring will provide sufficient information to make any lasting determinations. Information would provide clues or guidance into future monitoring or research needs.

Routine human monitoring will not be done unless project conditions or an emergency warrants. Procedures in the safety plan will be followed to obtain medical attention or treatment if needed.

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Because much of the long-term, indirect affects are extremely complicated and difficult to measure, it is doubtful that the project monitoring will provide sufficient information to make any lasting determinations. Information would provide clues or guidance into future monitoring or research needs.

Routine human monitoring will not be done unless project conditions or an emergency warrants. Procedures in the safety plan will be followed to obtain medical attention or treatment if needed.

II. PROJECT IMPLEMENTATION

The monitoring program must be implemented in a timely and efficient manner; however, safety considerations will not be sacrificed. Safe driving, hiking, and stream walking must be maintained. If the monitor will be late, let the COR or unit inspector know as soon as possible so plans can be made to reduce the conflict.

A. Station Selection

Specific station selection and total number in the program should be tempered by actual need based on various factors. Evaluating criteria should include priority sites (as listed), manpower availability, access problems, cost and other constraints, time, statistical relevance, travel distance, dilution factors, proximity to beneficial uses, social sensitivity, treatment method, complimenting mitigation requirements, topographic features, distance to live water, etc.

Prioritization can generally be applied to the following groups:

	Group	Monitoring Priority
I.	Requirements of the EA	REQUIRED
II.	Recommended by Selected State, Federal, Research fish or water personnel.	HIGH
III.	Other High Priority Uses 1/	MEDIUM
IV.	Evaluation of Application Methods and Safeguards. 2/	LOW

B. Prework

Topographic maps and aerial photos may be utilized for the entire spray program. There is, however, no better information than preknowledge of the actual field conditions. Treatment units, live streams, and expected monitoring sites should be located on aerial photos or suitable maps to aide personnel. Contingency monitoring sites and water use locations are also needed in sensitive areas. If possible, a string line should be run from the road to the site to aid monitors if they are expected to arrive during darkness. Equipment and materials will also have to be ready when needed (Appendix C is a partial list.)

1/ See "Priority Analysis" on Page 1 and proposed sites in Appendix H.

2/ Each contract should include a minimum quality control monitoring effort.

Stream travel times must be measured or estimated using appropriate salt or dye tracing methods. Adjustments may be necessary for changing flow conditions. An example of stream travel determination is presented in Appendix D.

Monitoring points should be located as close to the unit (treatment) boundary as reasonably possible so that maximum concentrations would occur and stream time of travel is limited (faster). Sample points may normally be approximately 500 feet below the unit boundary to avoid spray drift. However, under unusual or specific conditions, stations may be located up to a mile or more downstream.

C. Sample Collection Procedures

1. Containers

Sample containers are available from EPA approved laboratories. Preservatives and storage methods before analysis should be reviewed before collection. 1/

2. Collection

To reduce the chance of sample contamination, collection is best done by a trained individual who is not associated with the spray application. Application inspectors may be used to place and/or collect spray deposit cards where this is necessary to maintain operation efficiency and avoid contamination of water monitors.

Water samplers should take above normal precautions to maintain insecticide and dye-free clothing, skin, and equipment. All water sampling will be done with the assumption that the sampler was contaminated. Sample bottle and lid will usually be labeled prior to collection of sample because most markers do not write well on cold, wet containers.

Water Samples should be collected below a small falls or drop in the stream where all water not going into the bottle rapidly moves away from the opening. Hands should be as far as possible from the container mouth without sacrificing ability to support the sample. This technique has proven successful even after personnel had been hit with light drift. Sampling in pools must be strictly avoided. The water sampler must avoid walking in the stream above the collection point. Samples should be collected facing upstream. Care must also be exercised in the handling of the container mouth and lid to avoid contamination. Samples will be completely filled unless directed otherwise. 2/
Collection of aquatic insect drift or non-target organisms will be done using standard techniques and methods.

1/ To meet EPA analysis procedures, specially washed glass containers are required by EPA regulations (Roy Jones, EPA-Seattle).
2/ Composite samples are partially filled to predetermined levels.

3. Identification

After each sample is collected, care must be taken to fill out the sample I.D. tag and form correctly and completely. Each sample must be numbered, and the I.D. form given the identical number. When completed, the I.D. tag is to be attached to the container by rubber band, string, or tape.

A suggested numbering system (where containers are not pre-numbered) is as follows: 3 digit alpha or numeric code for site identification, 2 digit sample number code, and 1 digit sample type code (eg. MR101 B would be Murderers Creek #1, sample number 01, benthic sample). The date, time, and six digit code should also be placed on the container before sampling. Sample tags 11-2400-105 or equivalent may also be used to identify sample.

4. Sample Preservation and Storage

Standard procedures to preserve or store water and other samples must be adhered to for proper sample analysis. Water samples may need to be extracted in the field to stabilize the chemical (example extraction in Appendix E).

Sample handling should be documented if collector does not deliver sample directly to the Monitoring Coordinator. Transporting samples through areas recently treated required the collector and containers be inside vehicle and the vehicle closed. All samples unattended will be left in a locked vehicle. Sensitivity of the sample determines the possible "chain of custody" needs.

Water samples should be stored in a cool (about 4 C), dry, dark location, completely removed from insecticide and/or other chemical storage. Samples not analyzed will be stored for a period no longer than 6 months after collection. After 6 months' storage, samples will be disposed of by emptying on the ground, away from live streams. Contaminated container will then be disposed of by burying (refer to FSH 6109, HSC for safety precautions) or recycling through the laboratory. Samples may be disposed of earlier if Project Director and Monitoring Coordinator agree that further analysis is not necessary.

D. Sample Analysis Procedures

At least one sample from each site monitored would normally be sent in for residue analysis. However, if tracer dye or spray cards indicate no levels of insecticide concentration or drift, and the monitoring objectives are for quality control only, residue analysis is not a requirement. Samples will be sent to the laboratory in a timely manner. Other samples will be stored and analyzed as needed for verification. An investigation will be initiated for any sample indicating over 10 ppb insecticide. The extent of the investigation report depends on the significance and degree of contamination and should address causes, effects, and any necessary adjustments. Water samples may be submitted to the analyzing facility as composite or individual samples as follows:

Composite samples: Samples for analysis may be submitted as composites, i.e., equal parts of each sample taken at a collection point. The composite sample must be carefully prepared. This is the recommended method when a large number of samples are to be analyzed. No more than 4 or 5 individual samples, though, should normally be composited. Maximum concentration would be no greater than the analysis residue times the number of samples in the composite. For example, five water samples are added in equal portions to a composite sample. Lab results indicate 0.4 ppb carbaryl; the maximum concentration would be 5 X 0.4 ppb = 2 ppb carbaryl (assuming all the contaminant to be in one portion). Where dye readings are taken, the individual sample concentrations can be estimated using the dye concentrations as indicators.

Individual samples: Samples for analysis may be submitted as for analysis. The samples most likely to have the highest residue will be used to monitor water quality. Insecticide concentration may indicate that additional analyses should be run to determine contamination levels and reasons.

Lab detection and confirmation limits - as well as costs - vary. The lab will be selected based on the project needs relative to efficiency, costs, and certification. A few spiked samples may be used to check laboratory accuracy.

Fluorometer analysis when using fluorescent dye must be done by a trained individual. Care should be taken to guarantee that operation is according to instrument guidelines. A gasoline generator, when needed, must be in good working order and be compatible with the fluorometer. Dye standards are mixed using standard methods and have been generally reliable for a week or more at low concentrations below 0.5 ppb to a month for concentrations above 4 ppb. Sunlight degradation causes permanent change in concentration. Sample temperature changes cause a shift in the ability of a sample to fluoresence. Lower sample temperatures generally increase fluorescence. Standards should be run with adequate frequency to account for temperature shifts. Standards should be at or near the same temperature as the samples to obtain an accurate reading.

Standard curves should be plotted on log-log paper to insure linearity of standards. The line will shift as temperature changes. All sample analyses should be recorded in a bound book for legal purposes.

E. Recording and Reporting Procedures

Water monitoring records prepared will include the following:

1. Maps - The primary purpose is to show treatment areas monitored and monitoring points. The ½-inch to the mile Vicinity Map (project maps) are sufficient in most cases for permanent record, but should be incorporated into the monitoring summary report.

2. Sample Point Water Monitoring Record - A complete record of all samples collected and composites made for a sampling site. (Appendix F.)

3. Analysis Records - Time of travel information, tracer dye readings, aquatic insects and other supportive information should be recorded in a bound book. Residue analysis records from the analyzing facility will be retained.

4. Other - Information dealing with downstream use, monitoring priority, and remarks which might affect results. Examples of items to be included would be unusual weather conditions during and after treatment handling and storage procedures used, and any unusual incidents observed.

The reporting sequence begins with providing daily findings to the designated person(s) and ending with a program synopsis. The levels of reporting include:

(a) A daily report is provided by the Monitoring Coordinator to Project Director. This applies primarily to use protection where domestic uses or resource values are sensitive. Usually only positive findings will be reported. Negative findings - those less than the detectable concentration - will not be relayed unless requested. Report will be given by radio and/or in person immediately after analysis.

(b) Results of the analyses (an administrative report) will be made available to Project Director at the earliest possible date. This data summary will include only brief information such as unit monitored, number of dye, residue, insect drift, or benthic samples analyzed, results of analysis, and any pertinent remarks. This summary is especially important for project critique and for use protection or contingency monitoring where users are requesting additional information. Where aquatic insect samples have not been analyzed, visual interpretations may be presented.

(c) A monitoring summary report will be prepared on all monitored areas. The report should summarize the records including downstream uses, priority for monitoring, monitoring level, time of travel information, and sample analysis results. The sample point water monitoring record and topographic map showing measurement points should be included. Observer comments or other remarks should be included. Observer comments or other remarks should be included when helpful in explaining results. A copy of this report will be submitted to and reviewed by the Monitoring Coordinator and Project Director before samples are destroyed. The report will contain the significant detailed information dealing with all phases of the monitoring effort. The final report will be retained and maintained. Information could also be stored in TRI (microfilm) for future reference in the Aquatic Subsystem.

F. Monitoring Plan Deviation

Changes in the methods of collection are allowable if the situation demands adjustment or a better method has been developed. The Monitoring Coordinator should be contacted prior to deviating from planned procedures. Monitoring site additions are allowable if determined necessary by the Monitoring Coordinator if conditions warrant. However, these should have the concurrence of the Project Director and coordinated with other project personnel if possible. All significant changes must be documented - with reasoning included.

APPENDIX A

COMPUTATION OF POTENTIAL CONTAMINATION
(Peak and 24-Hour Mean Concentrations On-Site and at Downstream Locations)

Assume the worst situation that might occur (except for a spill) i.e., direct application to the stream and first compute the potential contamination on-site. Do this by computing potential contamination if the stream were sprayed at the same rate as in the spray unit. Next, determine or estimate stream flow discharges on-site and at point(s) of concern downstream. Determine the dilution rate between the project area and downstream point(s). Peak concentrations will diminish as water moves downstream due to channel dilution (peaks flatten), chemical degradation, and absorption of chemicals to sediments and organic matter. These additional factors could be considered in estimating potential downstream effects; however, adequate modeling data is lacking and there will be considerable variation depending on such factors as the stream characteristics and the specific pesticide used. For the purpose of evaluating potential water monitoring projects, it will be necessary to simply recognize these as safety factors, but not include them in the computations. Following is an example to illustrate the use of making preliminary computations.

Situation

An insecticide spray project is planned. One pound per acre of carbaryl will be applied. A stream borders the project for a distance of 1000 feet. It averages 10 feet wide and 1 foot deep. The stream discharge is 1 cubic foot per second. Since Velocity = Discharge - (Width X Depth), the average velocity is 0.1 feet per second. A municipal supply intake is located five miles downstream where the stream discharge is 10 cubic feet per second. Assume that no buffer strip is left and coverage of the stream is the same as in the spray unit.....in practice a buffer strip would be retained but the assumption is made to evaluate the maximum potential contamination. We want to determine the maximum potential peak concentration and the 24-hour mean concentration, both on-site and at the municipal supply intake.

On-Site Potential Contamination:

$$\text{PC On-Site} = \frac{368\ P}{D}$$

Where PC is peak concentration in parts per billion (ppb)

P is pesticide application rate in pounds per acre

D is average stream depth in feet

368 is a constant. It is a ratio: $\frac{\text{1 lb. of chemical/acre X } 10^9}{\text{lbs. of water 1 ft. deep/acre}}$

$$\text{PC On-Site} = \frac{368 \times 1}{1} = \underline{368}\ \text{ppb}$$

$$MC_{24} \text{ On-Site} = \frac{PC(L)}{86{,}400\ V}$$

where MC_{24} is the 24-hour mean concentration in parts per billion (ppb) PC is peak concentration in parts per billion - from the first equation.

L is stream length in feet

V is average stream velocity in feet per second

86,400 is a constant. It is the cubic feet of streamflow per day at a flow rate of 1 cubic foot per second.

$$MC_{24} \text{ On-Site} = \frac{368 \times 1000}{86{,}400 \times 0.1} = \underline{\underline{42.6 \text{ ppb}}}$$

Downstream Potential Contamination:

$$\text{PC downstream} \quad \text{PC On-Site} \times \frac{Do}{Dd}$$

where Do is stream discharge rate on-site and Dd is stream discharge rate downstream. If flow conditions are not known onsite and downstream watershed size is an indicator dilution. Replace Do with watershed size at the base of the treatment and Dd with watershed size at the downstream use.

$$\text{PC downstream} = 368 \text{ ppb} \times \frac{1 \text{ cfs}}{10 \text{ cfs}} = \underline{\underline{36.8 \text{ ppb}}}$$

$$MC_{24} \text{ downstream} = MC_{24} \text{ on-site} \times \frac{Do}{Dd}$$

$$MC_{24} \text{ downstream} = 42.6 \text{ ppb} \times \frac{1 \text{ cfs}}{10 \text{ cfs}} = \underline{\underline{4.3 \text{ ppb}}}$$

Similar calculations can be made for Zectran (mexacarbate). Zectran is applied at 0.125 lb/acre and the following is the calculation of potential contamination in the previous senerio:

$$\text{On-Site} \quad PC = \frac{368 \times .125}{1} = \underline{\underline{46 \text{ ppb}}}$$

$$MC_{24} = \frac{55 \times 1000}{86400 \times 0.1} = \underline{\underline{5.3 \text{ ppb}}}$$

$$\text{Downstream} \quad PC = 46 \times \frac{1}{10} = \underline{\underline{4.6 \text{ ppb}}}$$

$$MC_{24} = 5.3 \times \frac{1}{10} = \underline{\underline{0.53 \text{ ppb}}}$$

(Note: Downstream concentrations in this scenario would not meet the existing allowable concentrations for a public water supply. Presently, none is actually allowable because no standard is set for public water systems. Criteria listed in EPA publication 910/9-77-036 for carbaryl recommended a 24 hour mean concentration of 1 ppb as safe for potable use.

APPENDIX B

EXAMPLE DYE ADDITION TO INSECTICIDE SPRAY

Enclosed are the basic calculations for insecticide and Rhodamine Base BT dye mixtures to be mixed at the helicopter site. In these calculations the assumption was that 5 ppb insecticide was the minimum level necessary to detect with confidence. The fluorometer can detect to 0.1 ppb with confidence and to 0.05 ppb with less reliability. Therefore, 5 ppb insecticide divided by 0.1 ppb dye = 50:1 insecticide to dye ratio. Field measurements may allow detection of the insecticide at levels of 1-3 ppb, but these low concentrations are normally less accurate (greater variance) than with higher concentrations. (Insecticides for 1983 project are carbaryl (Sevin-4-oil) and mexacarbate (Zectran DB).

Insecticide Concentration

Application Rate of Mix	Mix Concentrations
Carbaryl 1/2 gal/acre	$\frac{1\# \text{ insecticide} \times .45359 \times 10^9}{1/2 \text{ gal mix} \times 3.7854} = 239,652,000$ ppb
Zectran 1 gal/acre	$\frac{.125 \times .45359 \times 10^9}{1 \text{ gal mix} \times 3.7854} = 14,978,200$ ppb

Dye Concentration (Rhodamine Base BT - 35% solution)

Carbaryl	$\frac{.0571 \text{ lb. dye} \times .45359 \times .35 \times 10^9}{1/2 \text{ gal} \times 3.7854} = 4,781,000$ ppb
Zectran	$\frac{.00714 \text{ lb.} \times .45359 \times .35 \times 10^9}{1 \times 3.7854} = 299,500$ ppb

Dye Added to 100 gal. tank (Dye = 0.95 g/ml)

Carbaryl 1/2 gal/acre spray	11.43 lb. X 453.6 g/lb. = 5185 g dye = 5458 ml dye
Zectran 1 gal/acre	0.714 lb. X 453.6 g/lb. = 324 g dye = 341 ml dye

The cost for the dye is roughly $8/pound for 400 ml (approx.), therefore, cost/acre for carbaryl would be $0.43 and Zectran would be $0.054. Amount of dye needed can be calculated as pounds of insecticide X .05714 = pounds of dye needed or pounds of insecticide X 27.3 = ml of 35% Rhodamine Base BT dye needed to be added to the mix.

APPENDIX C

CHECK LIST FOR WATER MONITORING FOR INSECTICIDES

approved sample containers
generator or power invertor
(in good working order - proper type for fluorometer)
gas and oil
extension cord (100 ft.)
distilled water
tap water
fluorometer 1/ 2/
    Far UV lamp GE G4T4/1
    Filters-primary 546 secondary 590
    cuvets and holder
kimwipes
portable radio
tracer dye (Rhodamine B or WT) 3/
volumetric cylinder (500 or 1000 ml) 1/
glassware - volumetric flasks 1/
pipets 1/
fluorometer standards
parafilm 1/
noniodized salt
cubitainer (1 gallon)
specific conductance meter
string measure device
flagging
packsack
sawdust (spill)
forms - Sample Point Monitoring Record
    - 11-2400-105 Sample Tag
    - other recording as needed
table (folding)
chair (folding)
sample cooler (when necessary)
hard hat (fluorescent red)
extra batteries (radio and light)
log-log paper 3 X 3 cycle

calculator
marking pens and lead

spray cards
head lamps
aerial photos
unit maps
monitoring plan
contract
spill plan
6 oz. whirlpak bag 1/
camera
insect key
fish key
insect & fish sampling
  equipment & materials
automatic water samplers
sample collection bottles
  samplers
sample preservation items

1/ Scientific Products
3660 148th Ave. NE
Redmond, WA 98052
800/426-2950

2/ American Instrument Co.
8030 Georgia Ave.
Silver Spring, MD 20910
Roger Leaf, Field Engr.
800/638-9670 x363

3/ Keystone Ingham
P. O. Box 669
Artesia, CA 90701
213/926-4461

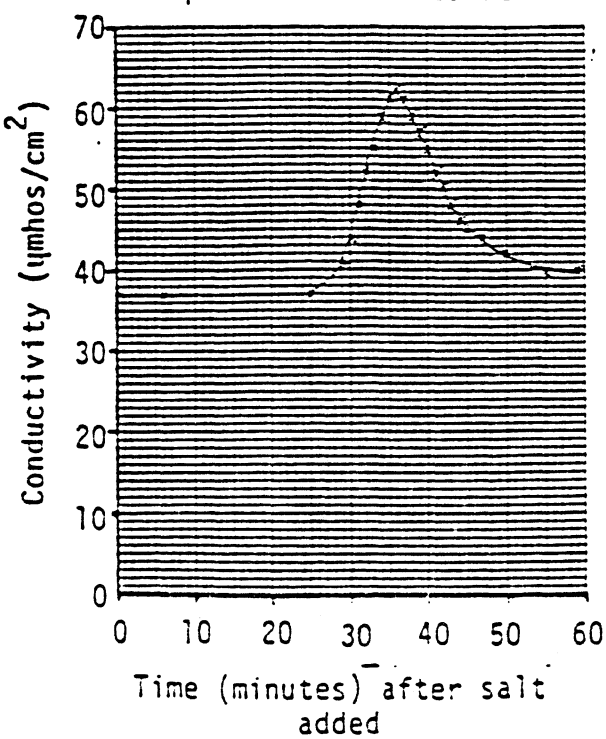
APPENDIX D

EXAMPLE OF STREAM TRAVEL DETERMINATION USING SALT DILUTION METHOD

Background: Stream travel time was measured in connection with a proposed herbicide unit in a District training exercise on March 29, 1978. Wakeup Rilea Creek was flowing approximately 3 cfs at the lower unit boundary with no noticeable dilution from downstream tributaries for ¼ mile where the monitoring site was planned. The figure below represents the stream travel time from adding approximately 3 lb. of salt over a 1 minute interval. Conductivities were 1000-2000 μmhos/cm^2 just below the salt addition point in Wakeup Rilea Creek. Measurements normally include flow time within the unit. The bell-shaped curve is standard in these studies, however, if the distance is long or the dilution (pools; flow velocity reduced) is great, the curve will become much flatter or even unnoticeable.

The figure shows the fastest water reaching the monitoring site after 25 minutes with peak salt movement after 36 minutes. For this situation a sampling interval of 10-15 minutes would be needed to ensure that a minor contamination is not missed.

Conductivity vs Streamflow Time Curve
for Wakeup Rilea Cr. 3-29-78



APPENDIX E

EXAMPLE OF TYPICAL WATER SAMPLE COLLECTION AND ORGANIC CHEMICAL EXTRACTION

1. Collect a quart or liter water sample as mentioned in Section II.C.2. Make sure sample is properly labeled.
2. Cover with aluminum foil or use a teflon liner in lid.
3. Place on lid and screw on tightly without tearing foil.
4. Store in dark and cool place until extracted - should be within 8 hours if possible; but 24 hours may be allowable.
5. Add 800 ml of sample into a 1 liter separatory funnel with teflon fittings.
6. Add 10 ml of 1 M Phosphate Buffer to adjust pH of the sample to 7.0.
7. Add 60 ml of Methylene Chloride and shake 1 minute. Vent funnel if necessary to avoid pressure buildup.
8. Allow layers to separate.
9. Drain Methylene Chloride into 6 oz. brown bottle which is properly labeled.
10. Repeat steps 7-9 two more times draining Methylene Chloride into same bottle.
11. Keep extracted samples cool and transport to lab when possible.

APPENDIX F

SAMPLE POINT WATER MONITORING RECORD

Ranger District ______________________ Sample Point No. ______________________

Entomological Unit ______________________ Legal T. ________ R. ________ Sec. ________

Location ____

Time of Spray Application: Start ______ Finish ______ Time of Travel Info ____________

Pesticide ______________________ Amount Active Ingredient ______________________ #/Acre

Pesticide/Dye Mixture Ration ________ : ____________

Sample Number	Date Sampled	Time Sampled	Name of Sampler	Type Sample	Remarks 1/

1/ Remarks to include information relative to sample, interpretation as weather, changes in flow conditions, storm, stream temperatures, spray application remarks.

APPENDIX G

Recommended concentration maxima for silvicultural chemicals by stream class and user group. Potable waters include safety factors for wildlife and aquatic organisms as well as humans.

Class	Chemical	Most Sensitive Test Species Affected	Test Basis & Concentration	Criteria, PPM 24 hr. Mean Stream Class & User: 10 cfs Potable	10 cfs Irrig.	10 cfs-Navigable Potable	10 cfs-Navigable Irrig.	Navigable Potable	Navigable Irrig.
Insecticide	Carbaryl	Stonefly	LC_{50} 48 hr, .0048 mg/l	.001	.001	.0005	.0005	.0002	.0002

(Taken from Silvicultural Chemicals and Potection of Water Quality, 1977. EPA 910/9-77-036)

APPENDIX H

Monitoring Locations and Priorities

Entomological Unit	Stream	Monitoring Priority	Remarks
Logan S1	Wolf Cr.	2	Resident Trout - may sample several tributary areas.
Logan S2	Summit Cr.	1	Fish Study Stream - resident trout drift on Larch Cr. may also be sampled
	Cotton Cr.	2	Resident trout - problem access.
Logan N	John Day - upper main stem	1	Sample Roberts Cr. (steelhead) and trout farm in conjunction.
Aldrich	Murderers Cr.	1	Fish Study Stream - steelhead.
	Deer Cr.	1	Fish Study Stream - steelhead.
	Tex Cr.	1	Primary steelhead spawning. Collectively these streams constitute primary spawning area in the South Fork John Day River.
P.A.	Clear Cr.	1	Fish Study Stream.
	Bridge Cr.	1	Recreation use lake (fish, etc.) just outside treatment area can be monitored in conjunction Lunch Cr. may also be monitored for aquatic drift.
Pogue Pt. 3			No monitoring - BT treatment.
Pogue Pt. 2	Summit Cr.	1	Zectran treatment evaluation. Idaho Cr. may also be monitored. Fish value would normally be priority 2.
Pogue Pt. 1	Vincent Cr. Vinegar Cr.	2 2	Both are important Middle Fork John Day streams.
Rudio 1 & 2	Rudio Cr.	2	Not as significant as others.
Matlock E	Camas Cr.	1	Chinook habitat, wildlife area.
	Fivemile Cr.	1	
	Scaffold Cr.	2	
Matlock W	Pontamus	1	
	Mallory	1	
Miller Prairie IN	Wilson	1	Very important small stream to North Fork John Day River.

APPENDIX H

(Continued)

Monitoring Locations and Priorities

Entomological Unit	Stream	Monitoring Priority	Remarks
	Skookum or Little Wall	2	Only access about 6 miles down stream.
Putney Mtn.	E. Meadow Brook	2	
	W. Meadow Brook	2	
	Desolation Cr.	1	Water sampling if necessary to assure Dale Ranger Station that adequate protection was achieved large dilution factor.
	Indian Cr.	1	Chinook habitat.
Other Treatment Areas			No planned monitoring at this time. Of course contingency monitoring will be activated as necessary on any area.
Previous Spray Area	Deep Cr.	1	Sampling of areas from 1982 Treatment Area in which streams indicated aquatic insect drift above normal. Deep Cr. was hit with insecticide fairly heavily. Monitoring to see if a reasonable amount of drift has returned.
	Deardorff Cr.	1	
	Lick Cr.	2	
	Reynolds Cr.	2	
	Upper Big Boulder	2	

Primary effort will be to accomplish monitoring on streams with fish studies, chinook spawning or rearing areas and other high value fish streams. Other special use sites as the recreation area on Bridge Cr., trout farm on upper John Day River, and water use at the Dale Ranger Station will receive necessary attention and adequate monitoring.

APPENDIX B

DIVISION 100 - GENERAL SPECIFICATIONS

110 - Scope of Contract

This project deals with collection of water resource information related to quality of surface waters on or adjacent to National Forest lands. There are eighteen (18) primary sampling site locations and thirty-one (31) associated secondary monitoring sites which will be visited intermittently until spraying on the Spruce Budworm Project ends.

111 The Contractor shall furnish all labor, materials, supplies, tools, instruments, equipment, qualified personnel, and vehicles required to successfully complete the terms of this contract.

112 The Contractor will be required to have a vehicle that is able to negotiate the terrain (all improved roads), which will be encountered in fulfilling the requirements of this job.

113 The contract time will begin upon award and end August 31, 1983.

114 The Contractor's field personnel will be in daily contact with designated Forest Service personnel during the prime spray period; approximately June 10 to July 15.

115 The Contractor or his field personnel will be available for 2 days of orientation by the Forest Service prior to the start of spraying.

116 A typed report of sampling results and analysis will be required.

120 - Project Location and Description

The following is a list of stations where sampling will occur during the life of this contract:

Unit 1/	Primary Site Stream Name	Exhibit No.	Number of Associated Secondary Monitoring Sites
1. Logan S1	Wolf Creek	2	3
Logan S2	Summit Creek	2	1
2. Logan N	John Day River	3	2
3. Aldrich	Murderers Creek	4	3-4
	Deer Creek	4	3-4
4. P.A.	Clear Creek	5	1
	Bridge Creek	5	1
5. Pogue Pt. 2	Summit Creek	5	2
6. Pogue Pt. 1	Vinegar Creek	5	2
7. Rudio 1 & 2	Rudio Creek	6	2
8. Matlock E	Five Mile Creek	7	1
	Camas Creek	7	2
	Scaffold Creek	7	0

1/ General Vicinity Map Exhibit 1 showing Entomological Units

DIVISION 100 - GENERAL SPECIFICATIONS (Cont.)

120 Project Location and Description (Cont.)

Unit	Primary Site Stream Name	Exhibit No.	Number of Associated Secondary Monitoring Sites
9. Matlock W	Pontamus Creek	7	0
	Mallory Creek	7	0
10. Putney Mtn.	Meadow Brook Cr.	8	3+
	Indian Creek	8	2
11. Miller Prairie 1N	Wilson Creek	9	1
1982-Spray Areas (Benthic and 24 hour Drift)1/	Deep Creek	10	
	Lick Creek	10	
	Big Boulder	10	
	Deardorff Creek	11	
	Reynolds Creek	11	
1983-Spray Areas (Benthic and 24 hour Drift)	Five sites identified following application within units listed above. Priority will be given to streams which had substantial drift. Prespray benthic samples at the 18 primary stations will be collected.		

NOTE: All 1983 Monitoring sites are approximate locations and site evaluation may shift location up or downstream to enhance monitoring effort. Changes will likely have little or no impact to the Contractor.

Each of the sampling stations is shown on the Forest Service maps which accompany this contract (Exhibits 2-11).

130 - Government-Furnished Property

The Government shall deliver to the Contractor the following listed materials, supplies, property, or services (hereinafter referred to as "Government-furnished property")at the places and times specified below. The Contractor shall be liable for all loss or damage of such delivered Government-furnished property until completion and final acceptance of work required under this contract. If the Government fails to make timely delivery of such Government-furnished property suitable for its intended use, and upon written request from the Contractor, the Contracting Officer shall make an equitable adjustment of contract delivery or performance dates or contract price, or both, pursuant to the "Changes" clause of the General Provisions of this contract.

131 The following materials will be made available to the Contractor at the pre-work conference:

1. A portable radio, extra batteries and instructions in use during the pre-work orientation session.

1/ An Example of Analysis needs for aquatic insects is presented in Exhibit 13

DIVISION 100 - GENERAL SPECIFICATIONS (Cont.)

130 - Government-Furnished Property (Cont.)

2. Reference maps: Forest Recreation Maps usually 3/8" = 1 mile scale of all Forests involved; individual Spray Block maps and Composite Spray Blocks maps. Maps will be made available to the Contractor at commencement of the contract period. One set will be provided.

3. Up to two days of field orientation in locating sampling sites and/or discussing methodology pre-work orientation session.

4. Two Copies of the Project Monitoring and Safety Plan.

5. Designate camping facilities for the Contractor or his personnel's use during the field sampling upon Contractor's request.

6. Spray cards sensitive to oil, dye, or components of the spray.

7. Instructions and materials for collecting animals found dead or in distress incidental to the Contractor's activities on the Project.

140 - Contractor's Qualifications

The Contractor or his project leader shall have sufficient training and experience to be knowledgable in the following areas:

1. Water sampling and extraction for organic chemicals.

2. Aquatic insects - sampling, counting, taxonomy to order, (may want to go to species for Plecoptera for a few samples).

3. Study design, implementation, and documentation.

The Contractor must demonstrate ability to successfully complete the project through past education (college credits) and/or experience (similar work).

DIVISION 200 - TECHNICAL SPECFICATIONS

210 - Sampling Specifications

211 Benthic Aquatic insects from 1982 sprayed areas. One composite sample of the benthic insect community from each of the five streams and sampling locations identified in Exhibits 10 and 11. A composited sample will consist of three to six subsamples from the same immediate location within a riffle area. Results of the composite sample will be reported as number of insects by order per unit area sampled. At least three square feet of substrate will be sampled. Collection information can be recorded on Exhibit 15.

212 Benthic Aquatic insects from streams within 1983 spray blocks.

One pre-spray benthic composite sample will be collected at each primary site. Post spray composite samples of the benthic insect community will be required at five primary sites during the period of the 1983 spray project. Sampling sites will be selected by the Forest Service. The same sampling procedures required in Division 200-210, Item 2 will be followed. Analysis of samples to be determined by the Forest Service, but the contractor should expect to count insects by order in samples from five sites.

213 Aquatic Insect Drift Sampling - Primary sites. Aquatic drift will be sampled at 18 primary sites both pre and post spray. Primary sites are marked with circles on Exhibits 2-9.

1. Pre-spray sampling will be done for a 24 hour period one or two days prior to the block being released for spraying and within a reasonable length of time after the Start Work Order is issued. Collection information will be recorded on Exhibits 14 and 16.

   A. Samples will be collected by six hour periods (approximate) and the identity of each six hour sample retained. A volumetric measurement will be made of each subsample.

   B. Preferred sampling periods are 5 a.m. to 11:00 a.m., 11:00 a.m. to 5:00 p.m., 5:00 p.m. to 11:00 p.m., and 11:00 p.m. to 5:00 a.m.

   C. The aquatic drift sampler will have a sufficient mesh size to allow fine sediments to pass through (nets with a 0.5 mm mesh are preferred).

DIVISION 200 - TECHNICAL SPECFICATIONS (Cont.)

210 - Sampling Specifications (Cont.)

213 Aquatic Insect Drift Sampling - Primary sites. (Cont.)

D. Drift sampler will be checked for performance more often when necessary. Conditions of increased runoff resulting from recent rainfall, heavy debris flow, or post-spray aquatic insect drift indicate the samples will have to be checked more frequently.

E. Location of pre-spray drift sample site will be marked in the stream so the same site can be located and sampled post-spray.

F. Analysis of the pre-spray sample will not be done until the post-spray sample has been collected. The number of six hour samples to be analyzed will be determined by the Forest Service. In most cases, the six hour samples will be composited before analysis. The Contractor should count on ordering and enumerating three composite aquatic insect drift samples related to the primary station (includes secondary sites).

2. Post-spray sampling will be done for a variable time period lasting normally 24 hours but up to 48 hours after the commencement of spraying. Unusual conditions due to weather, insecticide application, and stream travel time may alter normal sampling needs.

A. Sampling will begin as soon as spraying begins. Spraying may occur on any day of the week. It will be necessary for the Contractor and/or his personnel to maintain contact with spray headquarters and/or designated Forest Service personnel to determine when a specific block will be scheduled for spraying. Procedures for communication will be established during the pre-work session.

B. Sampling will stop when directed by designated Forest Service personnel.

C. All the following criteria will be followed as stated in Division 200-210, Item 213, 1. A, B, C, D, E, and F in taking pre-spray samples.

D. The same site will be sampled as during the pre-spray period and the sampling procedure will attempt to duplicate pre-spray conditions of sampling

DIVISION 200 - TECHNICAL SPECFICATIONS (Cont.)

210 - Sampling Specifications (Cont.)

214 Aquatic Insect Drift sampling - Secondary sites. Approximately 31 sites on streams will be sampled for aquatic drift. These 31 sites are located in proximity (both in distance and travel time) of primary aquatic drift sampling sites. Sampling at secondary sites will follow similar procedures as described for primary sites, however, less frequent servicing is allowable. A presample of variable duration will normally be collected at the time of site location until changing net to obtain post treatment drift. These samples will generally not be counted by insect order. Determination to analyze samples will be made by the Forest Service as visual comparisons will be made with samples collected from primary sites. Secondary sites are marked with an X on Exhibits 2-9.

215 Water sampling:

1. One pre-spray sample will be taken at each primary site.

2. One or two composite water samples will be taken at each primary aquatic drift post-spray site. The composites will generally consist of 5 subsamples taken at predetermined intervals after the initiation of spraying. The sampling schedule will largely depend on stream travel time measurements or estimates. Sampling information will be recorded on Exhibit 14 forms.

3. The Contractor and/or his personnel will have 20 extra water sampling bottles with them in the field to sample:

   A. Waters observed to have been sprayed with insecticide.

   B. Water if they observe significant amounts of aquatic drift occuring.

4. Water samples taken will be extracted with 8 hours after collection as necessary (example in Exhibit 12) and turned over to designated Forest Service personnel at a convienient time. All water samples and extracted samples must be kept cold (4-8° C) and in a dark place.

DIVISION 200 - TECHNICAL SPECFICATIONS (Cont.)

210 - Sampling Specifications (Cont.)

215 Water sampling: (Cont.)

5. The Contractor is responsible for providing water sample jars, separatory funnels, storage bottles, and chemicals needed for extraction (approximately 50 will be taken). Columbia Laboratories, Inc. (Corbett, Oregon) will analyze necessary samples. They may supply some of the needed equipment.

6. Water analysis for spray residue is not a required part of this contract. The proper samples to be analyzed will be determined by the Forest Service.

220 - Additional Specifications

Additional aquatic insect analyses, by number of individuals and to order, of Forest Service collected samples may be requested. The number of samples to be analyzed will not be known until after the project is completed. Extraction of water samples collected by the Forest Service may also be requested. Additional work, if necessary, will be added by a Change Order.

DIVISION 300 - INSPECTION AND ACCEPTANCE

310 - Inspection

1. The Contractor will be inspected periodically for compliance with the terms of this contract.

2. Arrangements for field inspections will be made during contracts at spray headquarters or via radio.

320 - Acceptance

1. A typed report of findings from analysis under Section 210 will be required by August 31, 1983. The report will detail the type of equipment used to sample aquatic insect drift and benthic organisms. Results of any water analyses related to contract work areas should be obtained and incorporated into the report.

2. The Contractor's work will be accepted if field inspections and the final reports are satisfactory.

DIVISION 400 - PAYMENT

410 - Payment

Request for partial payment may be made upon completion of 50 percent of the sampling and final payment processed upon submission of the report of findings.

Solicitation No. R6-4-83-

Exhibit 1

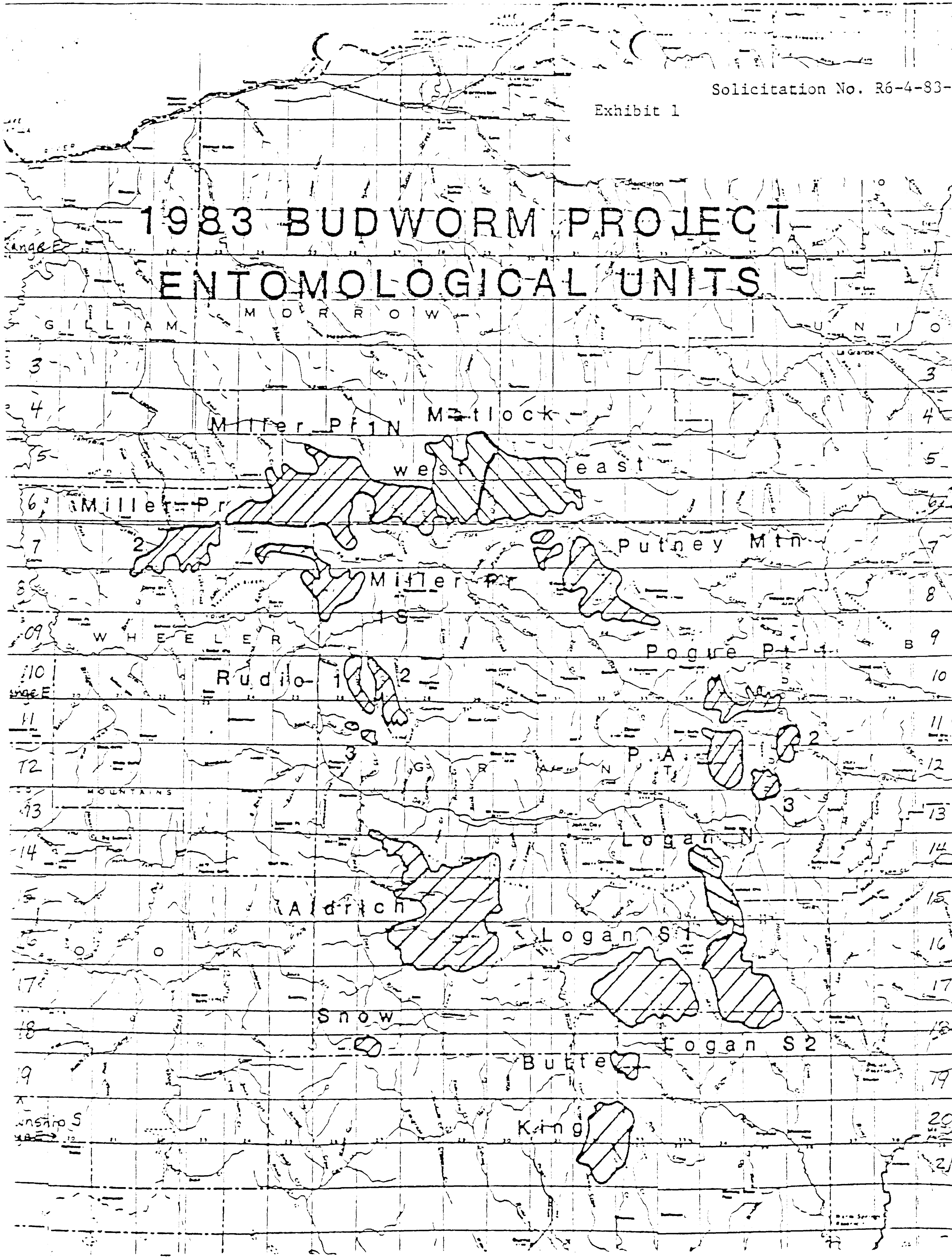


EXHIBIT 2

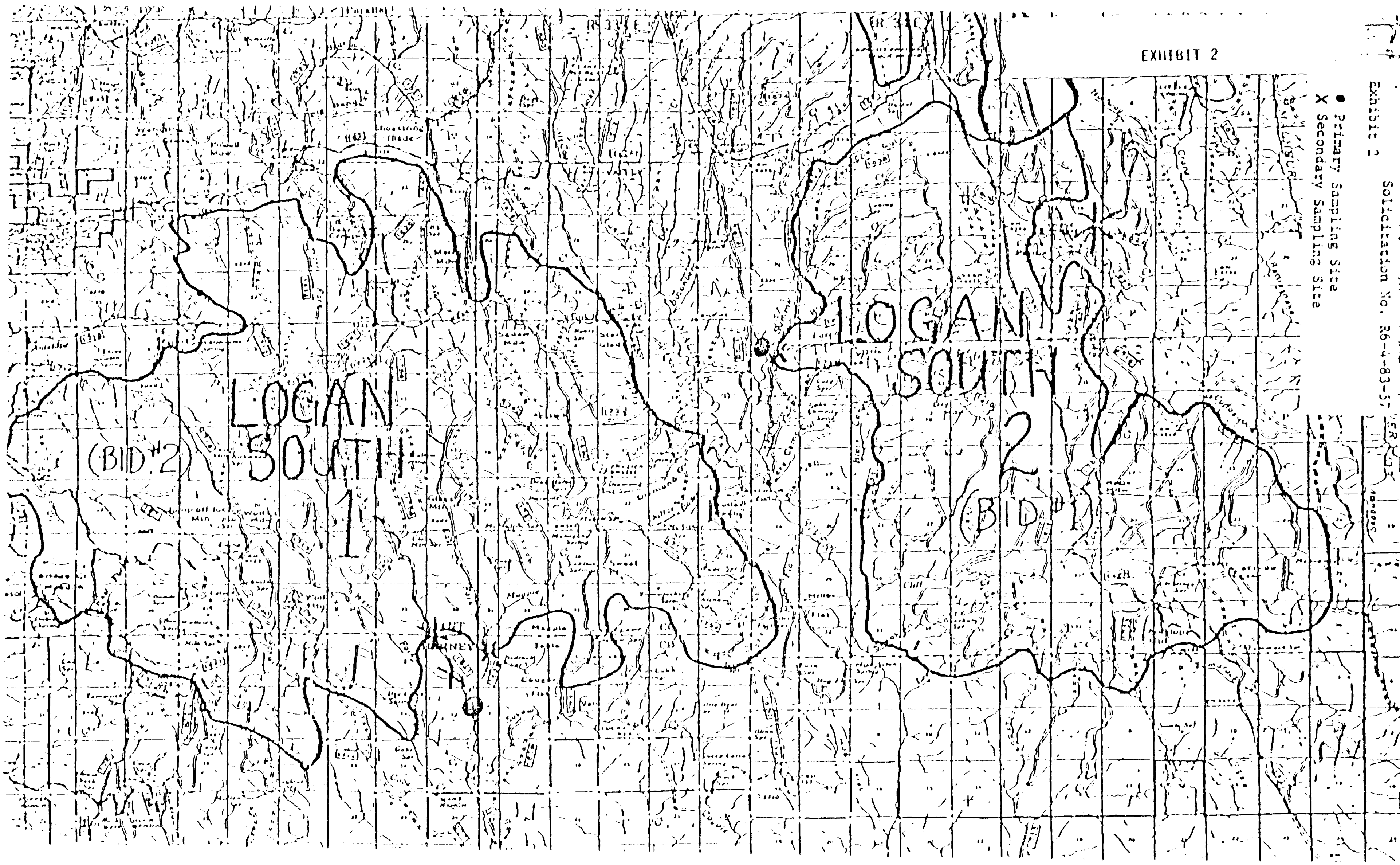


Exhibit 2
Solicitation No. R6-4-83-57
● Primary Sampling Site
X Secondary Sampling Site
LOGAN SOUTH 1
(BID #2)
LOGAN SOUTH 2
(BID #1)

Solicitation No. R6-4-83-57

Exhibit 3

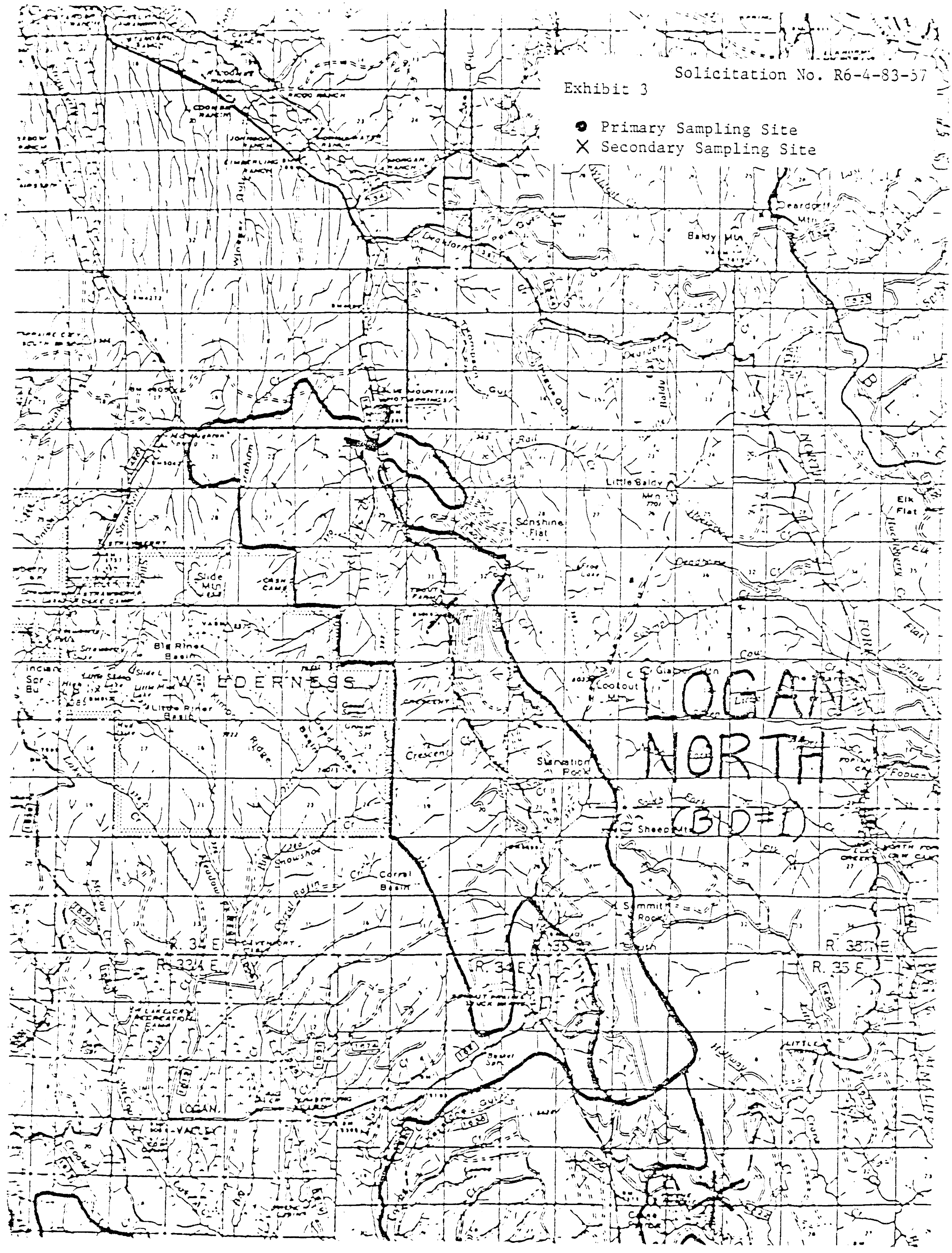
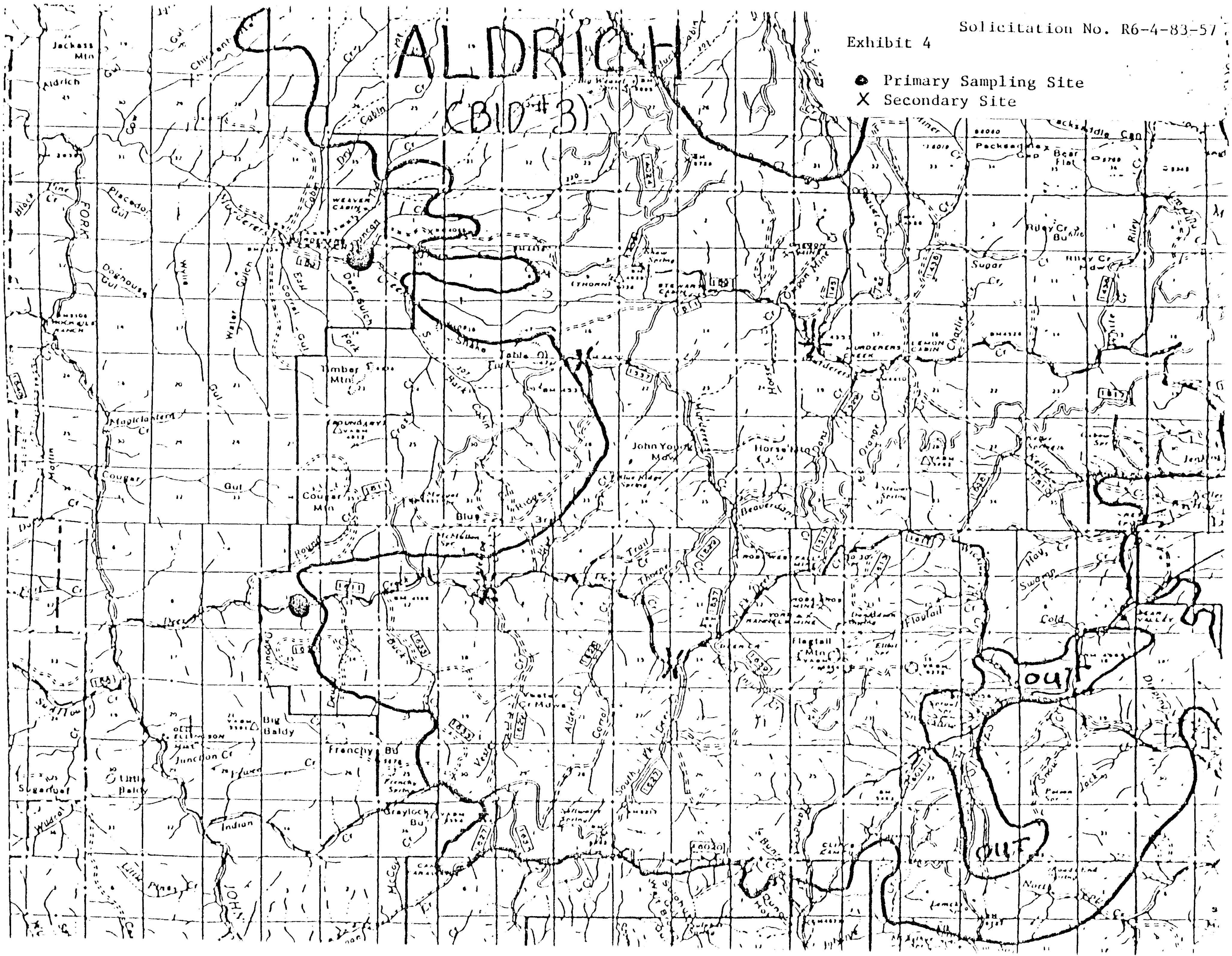


Exhibit 4


Primary Sampling Site
X Secondary Site
ALDRICH
(CBID #3)
Jackass Mtn
Aldrich
FORK
Placedor Gul
Doghouse Gul
Water Gulch
WEAVER CABIN
Deer Gulch
Timber Mtn
Cougar Mtn
Cougar
Gul
Magiclantern Cr
Blue Ridge
Snake Table
John Young Mdw
Horse Cr
Murderers Cr
MURDERERS CREEK
LEMON CABIN
Charlie
Orange
Beaverdam
Packsaddle
Bear Flat
Riley Cr
Sugar Cr
Flagtail Mtn
Flagtail
Swamp
Cold
Big Baldy
Frenchy Bu
Junction Cr
Little Baldy
Sugarloaf
Indian
Graylock Bu
Alder Cr
South Fk
OUT
OUT

Solicitation No. R6-4-83-57

Exhibit 5

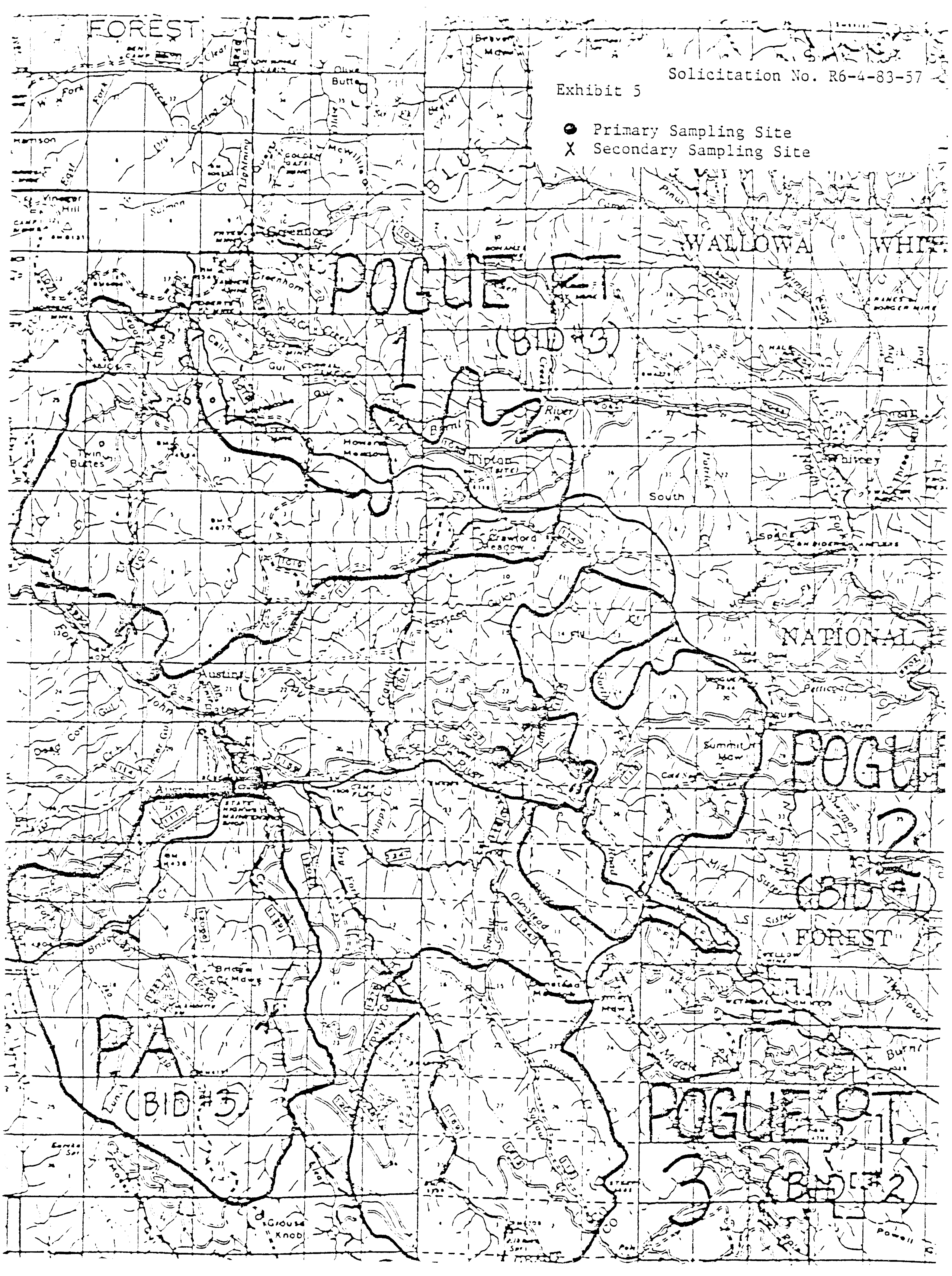
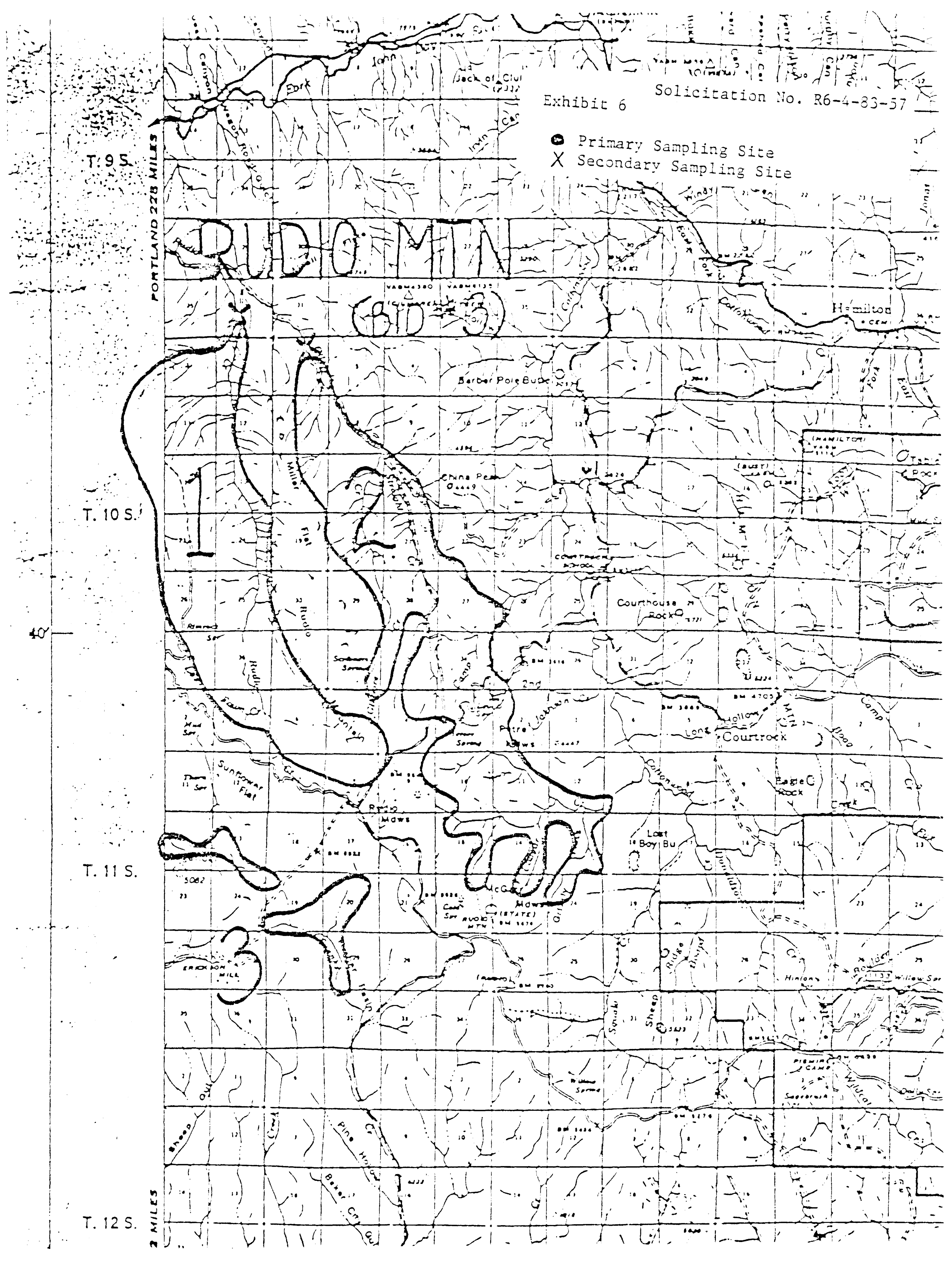
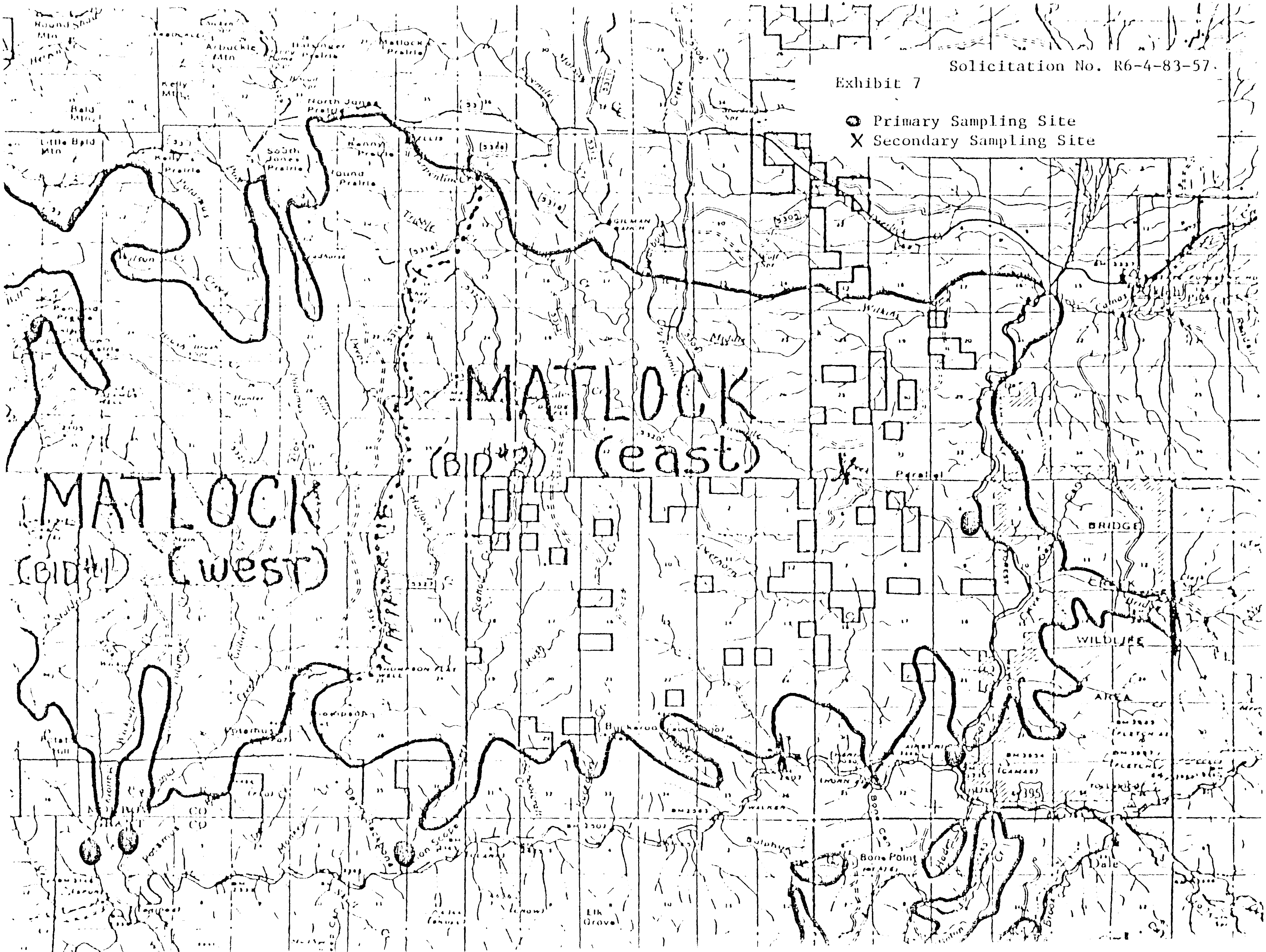


Exhibit 6

Solicitation No. R6-4-83-57




Solicitation No. R6-4-83-57
Exhibit 7
Primary Sampling Site
X Secondary Sampling Site
MATLOCK
(BD#2) (east)
MATLOCK
(BD#1) (west)
BRIDGE
WILDLIFE
AREA
Bone Point
Elk Grove
Dale
395

Solicitation No. R6-4-83-57

Exhibit 8

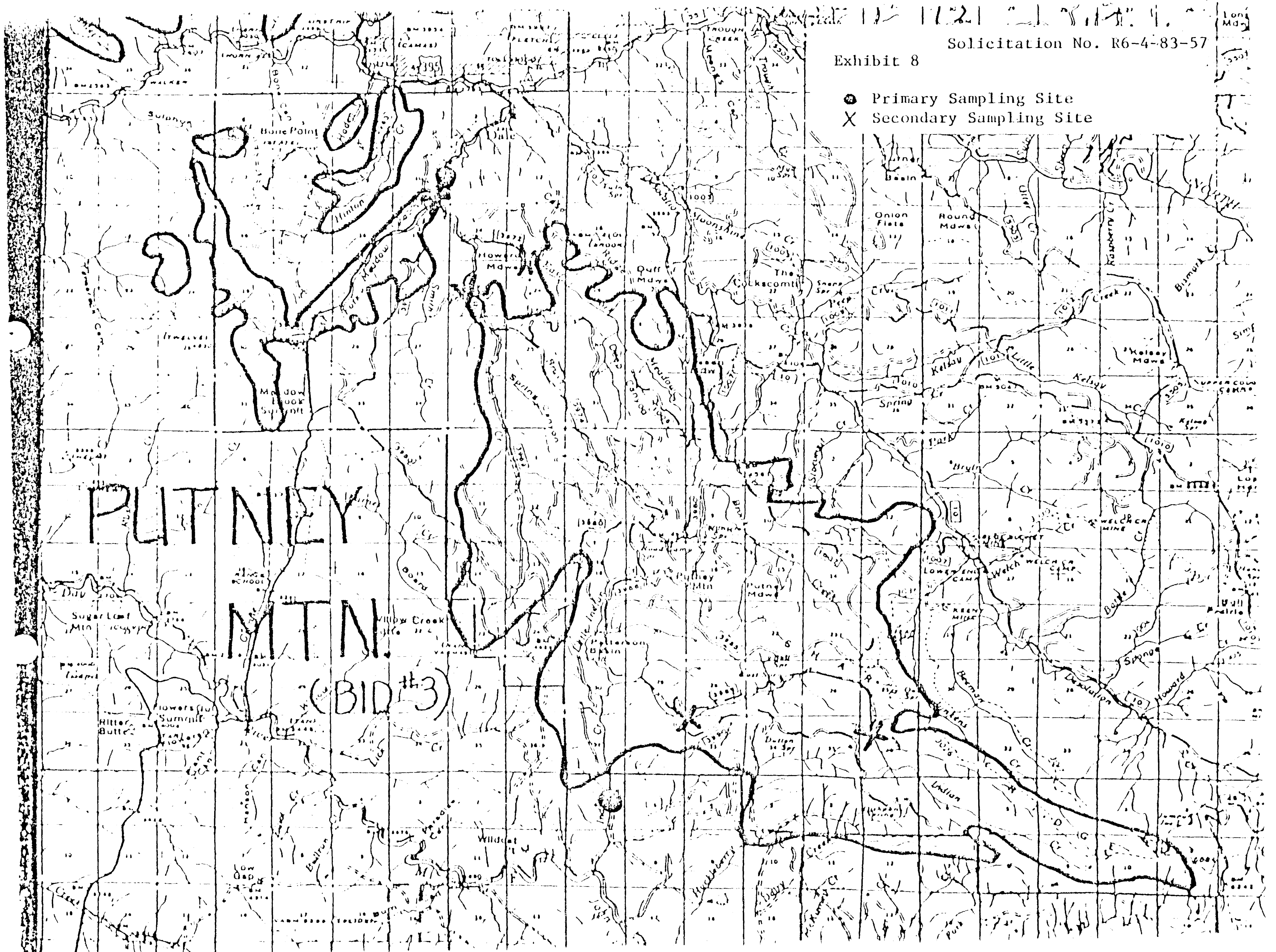
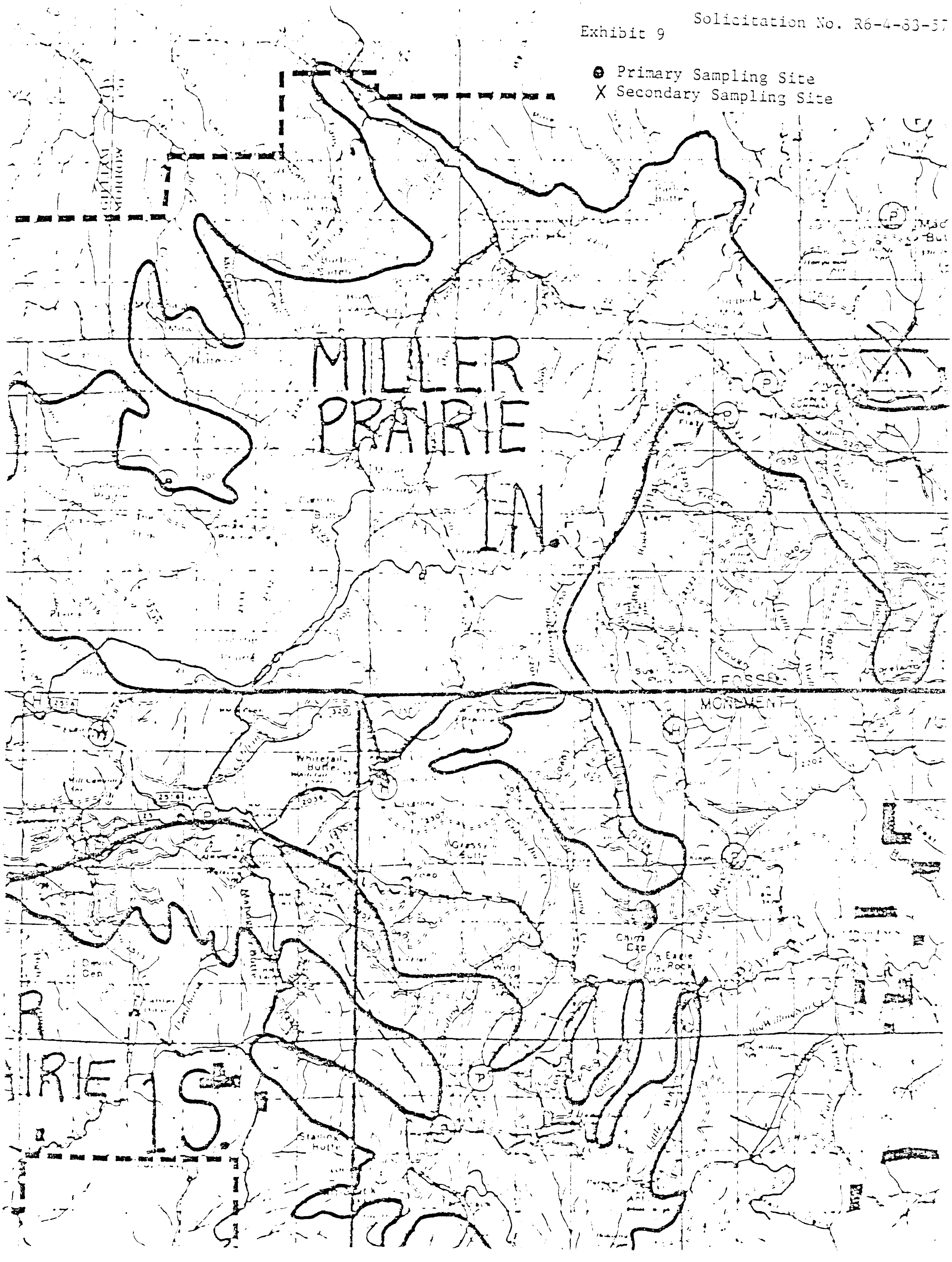
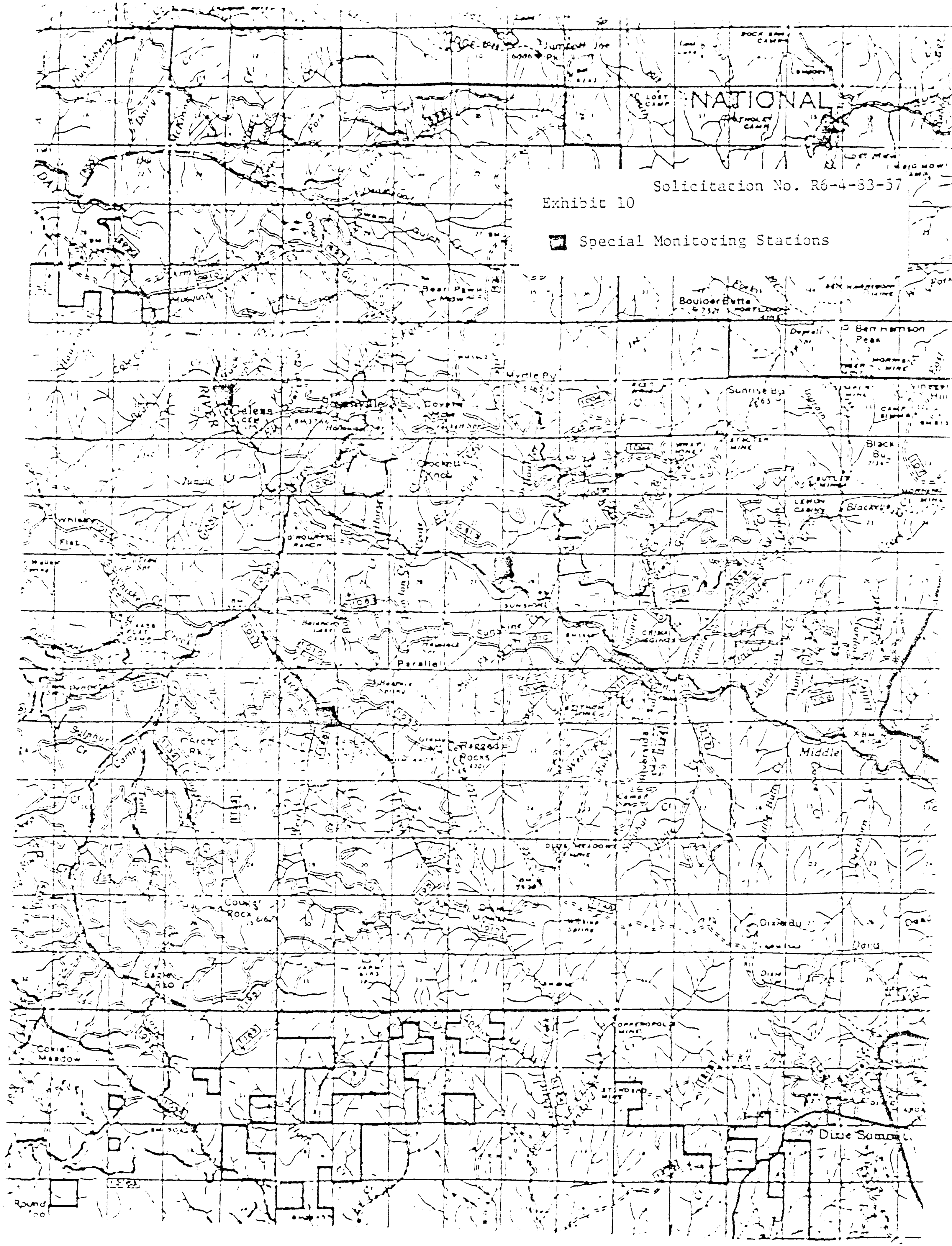


Exhibit 9

⊕ Primary Sampling Site
X Secondary Sampling Site




Solicitation No. R6-4-83-57
Exhibit 10
Special Monitoring Stations
NATIONAL
Galena
RIVER
Sunshine
Parallel
Boulder Butte
Sunrise Bu
Ben Harrison Peak
Black Bu
Crockett Knob
Ragged Rocks
Sulphur Cr
Whiskey
Flat
Middle
Dixie Bu
Eagle Rk
Cougar Rock
Cokie Meadow
Dixie Summit
Round

Solicitation No. R6-4-83-57

Exhibit 11

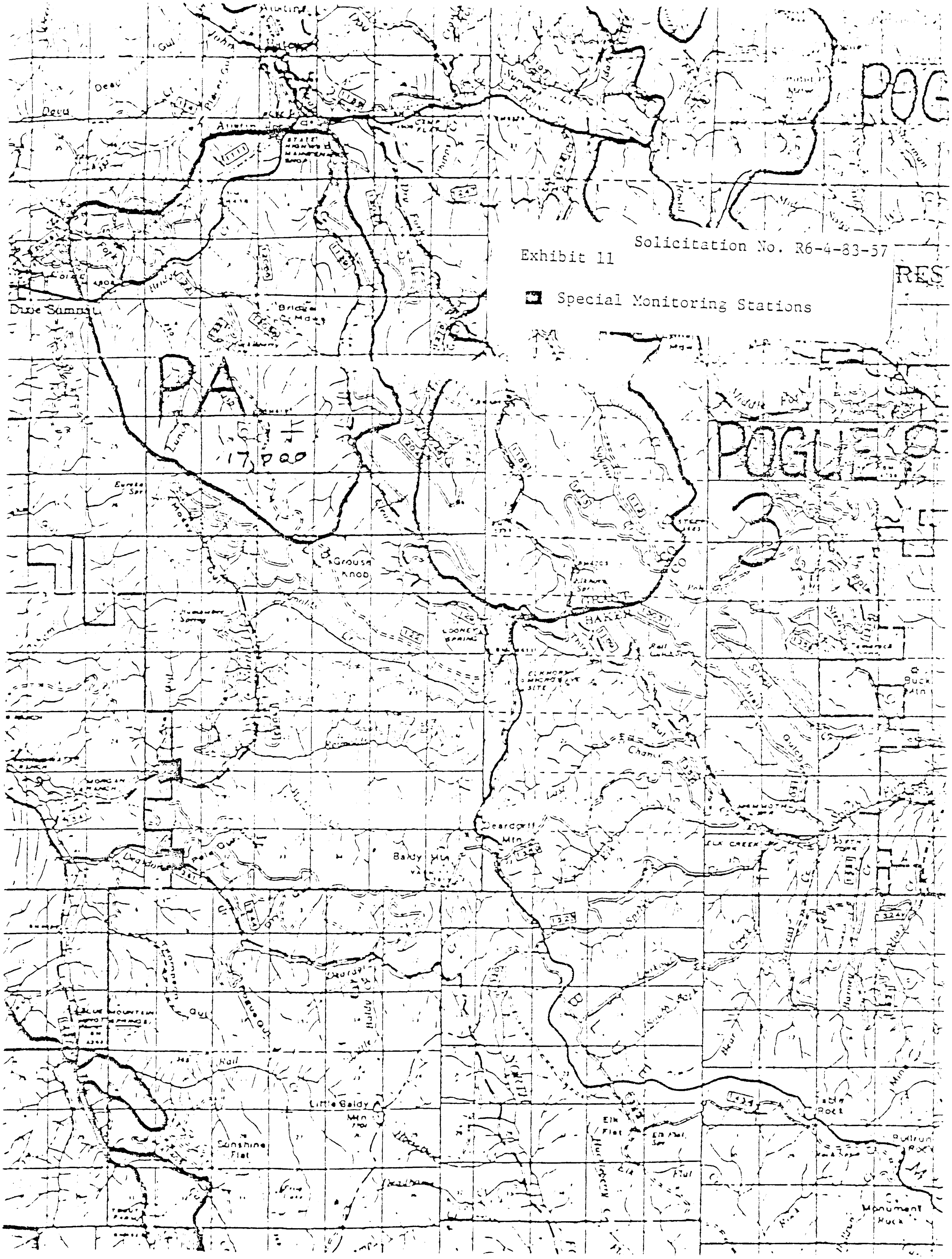


EXHIBIT 12

Example: Extraction of Organic Chemical In Water 1/

Collect 800 ml water sample if 1 liter seperatory funnel is used. Collect 1 liter water sample if 2 liter seperatory funnel is used. Water sample may be composed of several subsamples. Add water sample to seperatory funnel. Pour 60 ml of methylene chloride into original collection bottle. Shake well, vent, and pour into seperatory funnel. Shake well and let settle. Separate water and methylene chloride into separate containers. Twice add the 60 ml methylene chloride to the water sample, each time shaking, venting, and separating water from methylene chloride. Save methylene chloride sample for lab analysis - keep in cool, dark place until analysis by laboratory.

1/ Methods may vary slightly between chemicals, and should agree with Columbia Laboratory Inc. (Corbett, Or) Procedures and EPA standard methods.

Exhibit 13

Example: Counting Aquatic Insects by Order

Aquatic Insect Sampling will occur as directed in the contract specifications for drift or benthic populations. To reduce analysis costs, several samples may be combined to reduce the time strata variability factors if the insect numbers are too numerous. The composite sample may be split using standard methods to reach a representative subsample. The sample will then be divided as to insect order and the individuals will be counted and recorded on the proper record sheet (Exhibits 15 and 16). Aquatic drift from 1982 ranged from 174 to 3040 insects in a 24 hour period in prespray samples to a range of 268 to 93520 for postspray samples. Benthic populations per square foot ranged from 29-352 prespray to 28-670 postspray.

Solicitation No. R6-4-82-67
Exhibit 14

SAMPLE STATION WATER MONITORING RECORD

Ranger District ____________________ Sample Station No. ________________

Legal Description ____

Location Description ____

Time of
Spray Application: Start _____ Finish _____

Type of
Pesticide Used ______________

Sample Number	Date Sampled	Time Sampled	Name of Sampler	Remarks

Solicitation No. R6-4-83-57

EXHIBIT #15

BENTHIC INSECT COLLECTION RECORD

Stream Name ______________________ Stream Number ____________

Site Information ____

Dates Unit Treated ______________________________________

	Pre-Spray	Post-Spray	Post-Spray
Date & Time			
Area Sampled (sq.ft.)			
Order	# of Individ.	# of Individ.	# of Individ.
Ephemoptera			
Plecoptera			
Hemiptera			
Trichoptera			
Coleoptera			
Diptera			
TOTAL			
Sample Volume (ml)			

REMARKS: ____

Solicitation No. R6-4-83-57

EXHIBIT #16

AQUATIC INSECT DRIFT ANALYSIS RECORD

Stream Name ______________________ Station Number __________

Stream Width ________ Depth ______ Velocity ______ Flow ______ cfs

Sampling Location ______________________________________

	Pre-Spray	Post-Spray	Post-Spray	Post-Spray
Date Net Installed				
Time Net Installed				
Hrs. of Drift Sampled				
Order	**# of Individ.**	**# of Individ.**	**# of Individ.**	**# of Individ.**
Ephemoptera				
Plecoptera				
Hemiptera				
Trichoptera				
Coleoptera				
Diptera				
TOTAL				
Subsample	**Time/Vol.**	**Time/Vol.**	**Time/Vol.**	**Time/Vol.**
1.				
2.				
3.				
4.				
5.				
6.				

APPENDIX C

Monitoring Program Contacts

Merl Wischnofske, USFS (1982 Environmental Coordinator)

Roy Jones (EPA-Seattle)

Ernie Felix, (USFS-Umatilla Hydrologist)

John Andrews, (USFS-Umatilla Fishery Biologist)

Brady Greene, (USFS-Malheur Fishery Biologist)

Ross Wolford, (USFS-Malheur Hydrologist)

Cliff Bosley, (US Fish and Wildlife)

Irv Jones, (ODF&W-Portland)

Errol Clairre, (ODF&W-John Day District Fish Biologist)

Bill Hosford (ODF&W-Malheur District Fish Biologist)

Fred Everest (USFS Pacific Northwest Experiment Station)

Tom Merriam (Union Carbide)

Logan Norris (USFS Pacific Northwest Experiment Station)

Randy Perkins (Director 1983 Spruce Budworm Project)

Paul Buffum (Director-R6 Forest Pest Management)

Jim Haas (ODF&W-Portland, Chief Environmental Section)

Duane West (ODF&W-La Grande Fishery Biologist)

Len Franz (EPA-Seattle)

William Young (Oregon DEQ-Director)

John Marsh (Columbia River Intertribal Fish Commission)

Leon Murphy (USFS-R6 Director Fish and Wildlife)

Dick Miller (Taxon Aquatic Montoring Service)

APPENDIX D

WATER MONITORING FOR THE PRESENCE OF THE INSECTICIDE SEVIN DURING THE SPRUCE BUDWORM SPRAY PROJECT, MALHEUR AND UMATILLA NATIONAL FORESTS, JUNE AND JULY, 1983.

During the Spruce Budworm Spray Project, TAXON Aquatic Monitoring Service was hired by the U.S. Forest Service to collect water, benthic and drift samples on certain streams within the boundaries of the spray project. Before- and after-spray water samples were collected for chemical analysis. Before and after-spray samples of benthic and drift animals were collected. Benthic animals are those that live in the stream bottom, drift animals are detached benthos. These samples were later identified and counted in the laboratory.

METHODS

Water samples were collected before and after spraying. One 2 liter before-spray sample was taken at some convenient time, usually within 24 hours prior to spraying. After spraying began, four 500 ml water samples were collected at various times over a 24 hour interval, determined by time of water travel between the spray boundaries and the sampling point. An attempt was made to take a sample near the time of arrival of the possible pesticide containing water. Additional samples were collected at 2 to 6 hours, 12 hours and 24 hours after the first sample was collected. The subsamples were composited in a glass jug that contained a small amount of formaldehyde (20 ml) to prevent microbial decomposition of any pesticide that might be present. As soon after collection as possible (24 hours) the water was treated three times to a 50 ml methylene chloride wash for 5 minutes. This was done in a 2 liter separatory funnel, vigorously hand shaken for 5 minutes. The methylene chloride extract was collected into a light-protected aluminum foil- wrapped bottle and transferred to Forest Service personnel. TAXON was not responsible for chemical analysis of the pesticide. Extracted water was discarded.

Before-spray benthic samples were collected when it was convenient. After-spray samples were usually collected one to two weeks after spraying. Three samples were collected and composited. The collection device was a cylindrical enclosure that was placed over gravel and rocks in the stream bottom. One square foot was sampled. Each rock was carefully scrubbed by hand so clinging organisms would dislodge and collect into the downstream net. An attempt was made to sample a 3 inch depth of the substrate covered by 6 to 12 inches of water flowing at 0.5 to 1.0 feet per second. Areas with rocks 2 to 4 inches were selected. Collected organisms were placed into a jar containing formaldehyde and stored for later laboratory analysis.

Drifting stream organisms were collected by placing a net in the stream's current. This net had a 12 by 18 inch opening; fabric was 0.5 mm openings. Water depth 4 to 8 inches, and flow of 0.5 to 1.0 feet per second was selected. Two sampling regimens were followed. At certain locations primary sampling sites were established. Here four before-spray drift samples were collected at as close to 6 hour intervals as possible. These samples were taken a week or less before spraying. After spraying, nets were again installed and the procedure repeated. The second regimen, secondary sampling, called for taking only one sample during a 24 hour period before- and after-spray. The nets were cleaned near the midpoint of the period to reduce clogging. All samples were placed into jars containing formaldehyde and stored until laboratory analysis was performed.

Laboratory analysis of the benthic and drift samples was done by first hand picking organisms from the debris - needles, leaves, twigs, sand, rocks and algae. All organisms were then microscopically identified and counted. Most samples were of large volume. Picking all organisms within would have taken days or even weeks for each sample. A subsampling procedure was necessary to reduce picking time. Samples were placed into a container and brought to a volume of 4 liters with water. The contents were then stirred with a paddle in a figure eight pattern and a 400 ml aliquot was removed. Insects from this subsample were picked under magnification. If it was estimated that picking time was to exceed one hour, the subsample was further split. Subsample sizes ranged from 100%, no subsampling, to 1.25%. The majority of the subsamples were 5%.

Identification was to the level of order: Ephemoptera, mayflies; Plecoptera, stoneflies; Trichoptera, caddisflies; Coleoptera, beetles; and Diptera, true flies. Other aquatic organisms were also identified and counted but not included in the tables for analysis. Including these would reduce the sensitivity of the analysis because the pesticide is targeted to insects.

Stoneflies at selected sites were identified to the lowest possible taxonomic level. Information from these samples may be used in the future to help understand the effects on stonefly communities as a result of pesticide impacts on these streams, see Table 3: Plecoptera Larva In Selected Benthic Collections, 1982 and 1983 Spruce Budworm Project; and Table 4: Plecoptera Larva In Selected Drift Collections, 1983 Spruce Budworm Spray Project.

RESULTS AND DISCUSSION

Benthic samples were collected at 26 stream locations during the 1983 operations. Samples were collected on an additional 5 locations relative to the 1982 project. By analyzing 18 pairs of matched observations on Table 1, it is seen that mayflies, stoneflies and caddisflies are more sensitive to the spray than are beetles or true flies, a 20% reduction of numbers of these three orders occured in the after-spray samples. Stonefiles numbers decreased the greatest, 21% after-spraying. Of the 18 pairs, after-spray numbers were lower in 11 for mayflies, 12 for stoneflies and 14 for caddisflies. Of the five 1982 benthic samples, numbers of the three orders were 6% less in the after-spray samples.

A notation should be made of the large increase in total numbers of aquatic insects in benthic samples collected on October 1, 1983 on Bully, Indian and Lane creeks. Both Bully and Lane Creeks were suspected of having been oversprayed. A large increase in numbers is not unusual in the fall due to the lowering of water temperatures - increased dissolved oxygen - and an increase in the food supply in the form of fallen leaves and needles.

Drifting rate of aquatic insects from 54 stream sampling stations within the boundaries of the 1983 Spruce Budworm Spray Project were monitored. The purpose of this was to determine if large differences in the hourly rate of drifting insects occurred in streams associated with the spray project. If it can be determined that an increase in drift is associated with spraying, it must be assumed that some insecticide entered the water.

A wide variation in the rate of drift insects can occur naturally. Some of these causal factors are overcrowding and competition. As the animal grows it needs more space or as stream levels drop available space is reduced and new feeding sites may be sought. Morphological transformations of the insects larva into the next development stage and emergence can cause insect to release their hold in the stream. Also, unusual changes in light intensity, temperature, dissolved oxygen and stream levels may cause insects to drift. An upstream disturbance, such as animals walking in the steam may be a cause. An increase in the rate of drift does not necessarily indicate that the pesticide was introduced into the water. However, very large increases would be a cause to suspect an introduction of the pesticide occurred.

The results of our monitoring reveal the mean number of drifting insects is 80 per hour in the 49 samples collected before spraying; this compares with a mean of 331 insects per hour in the 83 samples collected after spraying. A wide variation exists in total numbers in these samples, Table 2. The rate of drift on a after-spray Indian Creek sample (INDIAN M) was 3 per hour whereas the before-spray drift was 236 per hour. variations of this type occur and should be expected due to the reasons given earlier in this report. Another factor not discussed is possible, differences in placement of the before-spray and after-spray nets. Three different people sat the nets on Indian Creek. It is possible that placement at one time was within an eddy, out of the main current, and the hourly water volume through the net varied from sample to sample. This seems unlikley because each of the after-spray samples collected on the INDIAN M site had very similar numbers. A more likely explaination is an upstream disturbance, an atmospheric disturbance or migration. Another case of large variation is seen in the numbers for Lane Creek - LANE -. 35 drifting insects per hour before-spray and 4549 after-spray. This differnce can easily be suspected of being pesticide related, the increase is large and is timed closely with the spray application.

The rate of drifting insects was lower after spraying in 30% (16) of the 54 sampling site. The greatest variation occured in Indian Creek with a before-spray number of 236 per hour and 3 per hour in the after-spray. In 15% (8) of the samples very little increase in the drift rate was recorded, 1% or less. An increase between 2 and 11 times the before-spray samples was observed at 35% (19) of the sampling sites and an increace of 11 to 130 times more insects than the before-spray samples was observed in 20% of the after-spray samples. In summary, 30% of the samples showed a decrease in drift after-spray and 70% of the samples an increase. The highest rate of increase occurred on Lane Creek, 130 times before-spray. The 11 streams with the highest rate of increase are:

Creek	Increase Of Total Insects		
Gillmore	11	times	before-spray
Wolf, West Fork	12	"	"
Meadowbrook, West Fork, Upper	13	"	"
Potamus	14	"	"
Sugar	15	"	"
White	24	"	"
Wickiup	28	"	"
Alder	38	"	"
Cottonwood	40	"	"
Bully, Lower	51	"	"
Lane	130	"	"

Of the streams listed above, West Fork Wolf Creek was known to have been oversprayed due to pilot disorientation. This was learned from a member of the flight crew. Less than a mile below the sampling station on West Fork Wolf Creek, a station existed for Wolf Creek. At this location water was from three forks of Wolf Creek. Here a rate of increase of 9 times the before-spray rate was recorded. Alder and Cottonwood Creeks were known to have been sprayed, due to the heavy concentration of the white spray particles of the pesticide on the rocks along the stream margins. Cow Creek is associated with a overspray and pesticide spill due to a helicopter crash.

Other streams not listed above but also having high rates of increase are:

Creek	Increase Of Total Insects		
Larch	8	"	"
Bridge, Lower	7	"	"
Deer, South Fork	6	"	"
Deer	5	"	"
Meadow Brook, East Fork, Lower	5	"	"
John Day, Lower	4	"	"
Tex	4	"	"

The increase on Deer Cr, South Fork can be attributed to the pesticide because overspraying of the creek was observed by the sampler. Tex Creeks rate of increase can be suspected of being pesticide related, especially since Sugar Creek, a tributary to Tex, also had such a large increase in drift rate, 1500%.

Spray droplets were observed on the Bridge, South Fork and must be assumed to have also been oversprayed. The post-spray numbers of drifting insects in the sample are higher than would have been expected.

TABLE 1: 1983 SPRUCE BUDWORM PROJECT - NUMBERS OF AQUATIC INSECTS IN COMPOSITS OF 3, 1 SQUARE FOOT BENTHIC SAMPLES BEFORE AND AFTER AERIAL SPRAYING OF THE INSECTICIDE SEVIN 4-OIL.

CREEK	DATE COLL		EPH	PLE	TRI	COL	DIP	SBTOT	TOTAL		NOTES
ALDER		B									1/
ALDER	710	A	63	19	9	5	2	91	98		
BIG BOULDER		B	42	51	15		12	108	120		2/
BIG BOULDER		A	156	63	54	12	54	273	339		2/
BIG BOULDER	705	A	76	16	21	14	87	113	214		
BRIDGE	630	B	124	102	38	106	98	264	468	]	
BRIDGE	709	A	141	14	35	99	73	190	362	[	
BULLY	625	B	127	10	10	9	26	147	182		
BULLY	1001	A	171	1	607	663	336	779	1778		3/
CAT		B									1/
CAT	710	A	3	34	1		3	38	41		
CLEAR	630	B	34	17	17	9	10	68	87	]	4/
CLEAR	709	A	279	160	17	14	21	456	491	[	4/
COTTONWOOD	628	B	176	56	150	140	302	382	824	]	
COTTONWOOD	709	A	61	16	71	61	61	148	270	[	
DEEP		B	114	15	9	48	30	138	216		2/
DEEP		A	24		12	42	27	36	105		2/
DEEP	705	A	198	10	32	56	342	240	638		
DEER	619	B	125	4	9	13	16	138	167	]	
DEER	708	A	30	2	4	5	1	36	42	[	
DEARDORFF		B	330	18	60	104	234	408	746		2/
DEARDORFF		A	198	69	42	81	99	309	489		2/
DEARDORFF	703	A	120	68	56	42	42	244	328		
FIVE MILE	615	B	44	3	13	22	16	60	98	]	4/
FIVE MILE	705	A	211	9	5	54	102	225	381	[	4/
IDAHO	621	B	64	150	42	162	54	256	472	]	
IDAHO	709	A	88	66	32	116	52	186	354	[	
INDIAN	623	B	37	23	51	29	60	111	200		
INDIAN	1001	A	216	80	240	88	208	536	832		3/
JOHN DAY	630	B	56	15	18	5	29	89	123	]	
JOHN DAY	710	A	107	53	33	52	52	193	297	[	

TABLE 1: 1983 SPRUCE BUDWORM PROJECT - NUMBERS OF AQUATIC INSECTS IN COMPOSITS OF 3, 1 SQUARE FOOT BENTHIC SAMPLES BEFORE AND AFTER AERIAL SPRAYING OF THE INSECTICIDE SEVIN 4-OIL.

CREEK	DATE COLL		EPH	PLE	TRI	COL	DIP	SBTOT	TOTAL	NOTES
LANE	627	B	146	62	110	24	166	318	508	]
LANE	705	A	90	6	38	66	296	134	496	[
LANE	1001	A	255	4	919	33	368	1178	1579	5/
LICK		B	105	15	18	24	54	138	216	2/
LICK		A	66	15	9	15	66	90	171	2/
LICK	705	A	242	72	74	102	280	388	770	
MALLORY		B								6/
MALLORY	705	A	20		24	23	116	44	183	
MEADOW BROOK	615	B	106	20	71	12	192	197	401	]
MEADOW BROOK	705	A	34	2	60	82	254	96	432	[
MURDERERS	619	B	74	27	9	14	31	110	115	]
MURDERERS	707	A	78	23	4	8	28	105	141	[
POTAMUS	620	B	82	18	53	25	221	153	399	]
POTAMUS	705	A	52	3	37	16	274	92	382	[
REYNOLDS		B	261	75	36	69	36	372	477	2/
REYNOLDS		A	288	84	27	135	117	399	651	2/
REYNOLDS	703	A	292	56	50	80	136	398	614	
RUDIO	609	B	235	42	27	107	201	304	612	]
RUDIO	703	A	204	54	92	148	908	350	1406	[
STONY	615	B	230	118	78	54	174	426	654	]
STONY	705	A	107	58	51	80	106	216	402	[
SUMMIT LOGAN	629	B	212	52	302	46	172	566	784	]
SUMMIT LOGAN	712	A	274	83	266	32	84	623	739	[
SUMMIT UPPER	621	B	244	76	44	212	152	364	728	]
SUMMIT UPPER	709	A	91	11	14	20	17	116	153	[
SUMMIT LOWER	621	B	198	38	96	126	54	332	512	
SUMMIT LOWER		A								6/
TEX	619	B	242	99	41	4	29	382	415	]
TEX	707	A	96	176	36	30	28	308	366	[
VINCENT		B								1/
VINCENT	709	A	52	46	29	37	59	127	223	
VINEGAR		B								1/
VINEGAR	709	A	4	13	12	34	32	29	95	

TABLE 1: 1983 SPRUCE BUDWORM PROJECT - NUMBERS OF AQUATIC INSECTS IN COMPOSITS OF 3, 1 SQUARE FOOT BENTHIC SAMPLES BEFORE AND AFTER AERIAL SPRAYING OF THE INSECTICIDE SEVIN 4-OIL.

CREEK	DATE COLL	EPH	PLE	TRI	COL	DIP	SBTOT	TOTAL	NOTES

WILSON	613 B	204	136	24	60	712	364	1136	]
WILSON	702 A	33	7	6	67	241	46	354	[

WOLF	629 B	56	161	85	28	43	302	373	]
WOLF	711 A	112	78	94	52	74	284	410	[

Total of 18 Prs. marked:

	EPH	PLE	TRI	COL	DIP	SBTOT	TOTAL
]	2454	1158	1131	1043	2618	4743	8364
[	2088	821	895	1002	2672	3408	7480
Percent change after spraying:	-15	- 29	-21	-3	+1	-20	-10

TABLE HEADINGS:

EPH = Ephemoptera
PLE = Plecoptera
TRI = Trichoptera
COL = Coleoptera
DIP = Diptera
SBTOT = Sum of EPH, PLE AND TRI.
TOTAL = Sum of EPH, PLE, TRI, COL, and DIP.

NOTES:

1/ = No pre-spray sample taken.
2/ = Collected during 1982 Spruce Budworm Project.
3/ = Original after-spray samples accidently destroyed, values are from samples taken on October 1, 1983.
4/ = Substrate size widely variable.
5/ = Samples taken on October 1, 1983.
6/ = Samples accidently destroyed.

TABLE2: 1983 SPRUCE BUDWORM SPRAY PROJECT - HOURLY RATE OF DRIFTING AQUATIC INSECTS BEFORE AND AFTER THE AERIAL SPRAYING OF THE INSECTICIDE SEVIN 4-OIL.

CREEK	DATE SET	HRS	EPH	PLE	TRI	COL	DIP	SBTOT	TOTAL	NOTES
ALDER	629B									1/
ALDER	707A	24	890	800	100	27	57	1790	1874	2/
ALDER	708A	23	2522	431	3	38	10	2956	3004	2/
BRIDGE	630B	21	38	2	2	19	6	42	67	
BRIDGE	703A	18	67	4	6	11	43	77	131	
BRIDGE	705A	23	297	57	14	77	19	368	464	
BRIDGE U	701B									1/
BRIDGE U	703A	71	18	11	3	11	2	32	45	
BRIDGE S	B									3/
BRIDGE S	707A	7	246	105	11	9	49	362	420	2/
BULLY L	625B	9	28	2	5	30	19	35	84	
BULLY L	626A	24	3046	620	325	63	188	3991	4242	
BULLY U	617B	25	12		6	5	2	18	25	
BULLY U	619A	25	15	1	4	16	2	20	38	
CLEAR	701B	30	64	1	3	5	5	68	78	
CLEAR	705A	23	55	9	23	9	15	87	111	
COW	B									4/
COW	712A	27	166	385	12	33	62	563	658	
COW	713A	6	22	20	3	3	3	45	51	
CORRAL	706B									5/
CORRAL	706A	23	400	113	31	66	10	544	620	
CORRAL	707A	25	44	6	3	10	1	53	64	
COTTONWO	628B	31	10	2	2	11	2	14	27	
COTTONWO	707A	17	6	8	1	2	5	15	22	2/
COTTONWO	708A	17	489	466	14	12	101	969	1082	2/
COTTONWO	708A	6	70	112	7	10	10	189	209	2/
DEER	619B	19	72	4	14	19	2	90	111	
DEER	706A	18	367	27	78	67	18	472	557	
DEER	707A	30	32	2	17	23	7	51	81	
DEER U	706B	21	77	6	15	56	5	98	159	6/
DEER U	707A	26	5	1	5	24	2	11	37	6/
DEER S	704B	48	20	1		9	6	21	36	
DEER S	706A	23	41		2	10	7	49	60	
DEER S	707A	25	166	19	19	16	2	204	222	7/

TABLE2: 1983 SPRUCE BUDWORM SPRAY PROJECT - HOURLY RATE OF DRIFTING AQUATIC INSECTS BEFORE AND AFTER THE AERIAL SPRAYING OF THE INSECTICIDE SEVIN 4-OIL.

CREEK	DATE SET	HRS	EPH	PLE	TRI	COL	DIP	SBTOT	TOTAL	NOTES
DEER N	619B	12	16	1	1	1	1	18	20	
DEER N	706A	23	8	3	1	4	2	12	18	
DEER N	707A	25	26	8	2	3	6	36	45	
FIVEMI L	615B	12	298	2	18	63	40	318	421	8/
FIVEMI L	616A	23	252	21	21	63	45	294	402	8/
FIVEMI U	615B									9/
FIVEMI U	616A	24	57	10	16	9	5	83	97	
GILLMORE	609B	24	17	1	2	20	15	20	55	
GILLMORE	613A	24	505	7	2	23	43	514	580	
IDAHO	621B	24	24	10	2	13	5	36	54	
IDAHO	702B	23	2	1		2	2	3	7	
IDAHO	704A	21	2	1	2	4	3	5	12	
IDAHO	705A	26	4	2	3	6	2	9	17	
INDIAN	623B	26	8	1	5	5	2	14	21	
INDIAN	628A	21	1			1		1	2	
INDIAN	629A	37	55	18	2	3	3	75	81	
INDIAN M	623B	15	188	9	15	21	3	212	236	
INDIAN M	628A	31	4	1	2	3	1	7	11	
INDIAN M	629A	26	1		2			3	3	
INDIAN U	623B	15	98	44	9	4	7	151	162	
INDIAN U	628A	30	43	2	5	2	3	50	55	
JOHN D L	629B	10	51	18	5	4	5	74	83	
JOHN D L	630A	25	51	3	2		14	56	70	
JOHN D L	701A	9	6	1	1	1	1	8	10	
JOHN D L	703A	24	213	82	15	2	25	310	337	
JOHN D U	629B	46	18	5	5	3	7	28	33	
JOHN D U	703A	24	80	17	3	7	20	100	127	
LANE	627B	12	21		3	1	10	24	35	
LANE	628A	14	2640	1063	457		389	4160	4549	
LANE	629A	19	53	15	23	8	65	91	164	
LARCH	628B	23	5	1	1	5	1	7	13	
LARCH	710A	10	3	1	1	4	6	5	15	
LARCH	711A	25	6	14	3	3	81	23	107	

TABLE2: 1983 SPRUCE BUDWORM SPRAY PROJECT - HOURLY RATE OF DRIFTING AQUATIC INSECTS BEFORE AND AFTER THE AERIAL SPRAYING OF THE INSECTICIDE SEVIN 4-OIL.

CREEK	DATE SET	HRS	EPH	PLE	TRI	COL	DIP	SBTOT	TOTAL	NOTES

LITTLE W	613B	24	18		2	3		20	23	
LITTLE W	615A	24	14	2	5	3	1	21	25	

LUNCH	701B	18	62	3	5	8	3	70	81	
LUNCH	705A	23	7	1	2	6		10	16	
LUNCH	707A	8	3		5	5	1	8	14	

MALLORY	620B	28	91	1	1	9	7	93	109	
MALLORY	628A	13	34			8	6	34	48	
MALLORY	629A	12	57	2		3	12	59	74	

MB WF L	615B	25	34		8	37	8	42	87	
MB WF L	617A	24	22		3	38	3	25	66	
MB WF L	618A	24	58	13	13	52	37	84	173	

MB WF U	615B	18	8	1	1	3	1	10	14	
MB WF U	617A	24	3		2	4	1	5	10	
MB WF U	618A	24	132	21	12	6	6	165	177	

MB EF L	617B	27	13	1	3	24	5	17	46	
MB EF L	621A	23	103	83	16	10	28	202	240	

MB EF U	618B	14	49	5	3	2	1	57	60	
MB EF U	621A	25	13				6	13	19	

MURDE	619B	19	124	13	6	34	244	143	421	
MURDE	620A	29	193	135	19	22	30	347	399	

MURDE M	619B	12	123	2	7	25	3	132	160	
MURDE M	630A	30	4		1	1		5	6	

MURDE U	630B	30	4	3	11	3	2	18	23	
MURDE U	703A	50	3	2	2	1	1	7	9	

MURDE SF	619B	12	15	1		6	1	16	23	
MURDE SF	619A	34	10	1	1	11	5	12	26	

NONAME	629B	22	4	11	1	17	4	16	37	10/
NONAME	703A	24	8	18	3	3	2	29	34	10/

POTAMUS	620B	29	4			1	6	4	11	
POTAMUS	626A	24	2			2	3	2	7	
POTAMUS	628A	13	46	34	11	66	2	91	159	
POTAMUS	629A	12	12	4	5	13	8	21	42	

TABLE2: 1983 SPRUCE BUDWORM SPRAY PROJECT - HOURLY RATE OF DRIFTING AQUATIC INSECTS BEFORE AND AFTER THE AERIAL SPRAYING OF THE INSECTICIDE SEVIN 4-OIL.

CREEK	DATE SET	HRS	EPH	PLE	TRI	COL	DIP	SBTOT	TOTAL	NOTES
ROBERTS	629B	10	52	24	4	4		80	84	
ROBERTS	630A	35	139	22	8	3	13	169	185	
RUDIO L	609B	24	6			5	13	6	24	
RUDIO L	612A	33	5			2	3	5	10	
RUDIO U	609B	36	2			1	1	2	4	
RUDIO U	612A	25	5	1	1	2	7	7	16	
STONY	615B	4	190	15	5	70	80	210	360	
STONY	616A	30	96	5		53	19	101	173	
SUGAR	619B	14	43	8	4	3	5	55	63	
SUGAR	630A	29	897	4	29	3	3	930	936	
SUMMITLO	628B	23	43	1	13	17	5	57	79	
SUMMITLO	710A	24	9		2	8	3	11	22	
SUMMITLO	711A	23	24	1	3	4	6	28	38	
SUMMIT L	621B	25	21	1	10	15	2	32	49	
SUMMIT L	625A	25	11	4	13	30	4	28	62	
SUMMIT U	621B	24	13	3	4	13	5	20	38	
SUMMIT U	625A	26	2	1	3	5	4	6	15	
SUMMIT U	704A	23	5	3	1	8	1	9	18	
SUMMIT U	705A	13	1	2	1	3	1	4	8	
TEX	619B	13	39		1	10	22	40	72	
TEX	620A	26	164	16	31	27	33	211	271	
THORPE	705B	25	35	10	5	6		50	56	
THORPE	706A	23	37	8	4	6	2	49	57	
VESTER	706B	22	21	23	1	1	5	45	51	
VESTER	707A	26	32	44	2	6	5	78	89	
WHITE	630B	30		4	2	1		6	7	
WHITE	703A	27	13	146	4	1	2	163	166	
WICKIUP	709B	24	39	3	1	1	2	43	45	
WICKIUP	710A	10	13	2	4		4	19	23	
WICKIUP	711A	25	942	117	58	4	187	1117	1308	
WOLF	629B	14	23		7	4		30	34	
WOLF	630A	24	155	8	108	13	13	271	297	11/

TABLE2: 1983 SPRUCE BUDWORM SPRAY PROJECT - HOURLY RATE OF DRIFTING AQUATIC INSECTS BEFORE AND AFTER THE AERIAL SPRAYING OF THE INSECTICIDE SEVIN 4-OIL.

CREEK	DATE SET	HRS	EPH	PLE	TRI	COL	DIP	BLANK	SBTOT	TOTAL	NOTES
WOLF EF	629B	13	30	1	2	4	1		33	38	
WOLF EF	630A	23	62	2	10	3	3		74	80	

WOLF MF	629B	14	16	1	1	2	1		18	21	
WOLF MF	630A	24	48	1	7	11	8		56	75	

WOLF WF	629B	14	84	1	17	13			102	115	
WOLF WF	630A	25	1075	131	74	29	26		1280	1335	12/

TABLE 2: 1983 SPRUCE BUDWORM SPRAY PROJECT - HOURLY RATE OF DRIFTING AQUATIC INSECTS BEFORE AND AFTER THE AERIAL SPRAYING OF THE INSECTICIDE SEVIN 4-OIL.

Explaination of headings:

DATE SET = Date net was installed in stream. Letter after the date indicate if sample was taken before (B) or after (A) spraying.
HRS = The number of hours drift nets were left in stream.
EPH = Ephemeroptera (mayflies).
PLE = Pleacoptera (stonefiles).
TRI = Trichoptera (caddisflies).
COL = Coleoptera (beetles).
DIP = Diptera (true flies).
SBTOT = Total of EPH, PLE, AND TRI.
TOTAL = Total of EPH, PLE, TRI, COL and DIP.

NOTES:

1/ Sample lost.
2/ Spray particles on rock and vegetation along stream channel.
3/ No pre-spray sample taken.
4/ Spill site, no pre-spray sample taken.
5/ Spraying while before-spray sample net in stream therefore this sample changed to after spray.
6/ Large amounts of leaves and branches in drift.
7/ Overspraying of creek seen by sample collector.
8/ Not positive of spraying time.
9/ Before-spray sample accidently destroyed.
10/ Trout Farm campground, Logan North Unit.
11/ Downstream of WOLF WF that was know to have been sprayed.
12/ Oversprayed due to pilot error.

Creeks:

ALDER	Logan S2
BRIDGE L = Bridge, Lower	P.A.
BRIDGE U = Bridge, Upper	P.A.
BRIDGE S = Bridge, South Fork.	P.A.
BULLY L = Bully, Lower.	Putney Mtn.
BULLY U = Bully, Upper.	Putney Mtn.
CLEAR	P.A.
COW	
CORRAL	Aldrich
COTTONWD = Cottonwood.	Logan S2
DEER	Aldrich
DEER U = Deer, Upper.	Aldrich

TABLE 2: 1983 SPRUCE BUDWORM SPRAY PROJECT - HOURLY RATE OF DRIFTING AQUATIC INSECTS BEFORE AND AFTER THE AERIAL SPRAYING OF THE INSECTICIDE SEVIN 4-OIL.

Creeks, Cont'd.

DEER S = Deer, South Fork.	Aldrich
DEER N = Deer, North Fork.	Alcrich
FIVEMI L = Fivemile, Lower.	Matlock E
FIVEMI U = Fivemile Upper.	Matlock E
GILLMORE	Rudio
IDAHO	Pogue 2
INDIAN	Putney Mtn.
INDIAN M = Middle.	Putney Mtn.
INDIAN U = Upper.	Putney Mtn.
JOHN D L = John Day Lower.	Logan N
JOHN D U = John Day Upper.	Logan N
LANE	Pearson
LARCH	Logan S2
LITTLE W = Little Wilson.	Miller Pr. 1N
LUNCH	P.A.
MALLORY	Matlock west
MB WF L = Meadow Brook, West Fork, Lower.	Putney Mtn.
MB WF U = Meadow Brook, West Fork, Upper.	Putney Mtn.
MB EF L = Meadow Brook, East Fork, Lower.	Putney Mtn.
MB EF U = Meadow Brook, East Fork, Upper.	Putney Mtn.
MURDE = Murderers.	Aldrich
MURDE M = Murderers, Middle.	Aldrich
MURDE U = Murderers, Upper.	Aldrich
MURDE SF = Murderers, South Fork.	Aldrich
NONAME	Logan N
POTAMOUS	Matlock West
ROBERTS	Logan N
RUDIO L = Rudio, Lower.	Rudio
RUDIO U = Rudio, Upper.	Rudio
STONY	Matlock West
SUGAR	Aldrich
SUMMITLO = Summit, Logan Unit.	Logan S2
SUMMIT L = Summit, Lower.	Pogue 2
SUMMIT U = Summit, Upper.	Pogue 2
TEX	Aldrich
THORPE	Aldrich
VESTER	Alcrich
WHITE	Aldrich
WICKIUP	Logan S2
WOLF	Logan S1
WOLF EF = Wolf, East Fork.	Logan S1
WOLF MF = Wolf, Middle Fork.	Logan S1
WOLF WF = Wolf, West Fork.	Logan S1

TABLE 4: NUMBERS OF PLECOPTERA LARVA IDENTIFIED TO THE LOWEST POSSIBLE TAXON IN SELECTED DRIFT SAMPLES, 1983 SPRUCE BUDWORM PROJECT, MALHEUR AND UMATILLA NATIONAL FOREST. NUMBERS = X/10.

CREEK	PTE	YOR	AMP	NEM	VIS	ZAP	PAR	ACR	CAL	DOR	PDE	PDN	ARC	ISO	ISP	CHL
ALDE			8													8
BRID			36					8			52					46
BULL						80					20					
COW			800									64				24
COTT											7					6
DEER	4		4				4							20	4	12
JOHN		12					4	8		4			8			152
LANE			96					704	272		64					288
MURD																408
WOLF			24	16	42	16	24									160

CREEK CODE	CREEK NAME	DATE COLLECTED
ALDE	Alder	7/08
BRID	Bridge	7/05
BULL	Bully, lower	6/26
COW	Cow	7/12
COTT	Cottonwood	7/08
DEER	Deer	7/06
JOHN	John Day	7/03
LANE	Lane	6/28
MURD	Murderers	6/20
WOLF	Wolf, WF	6/30

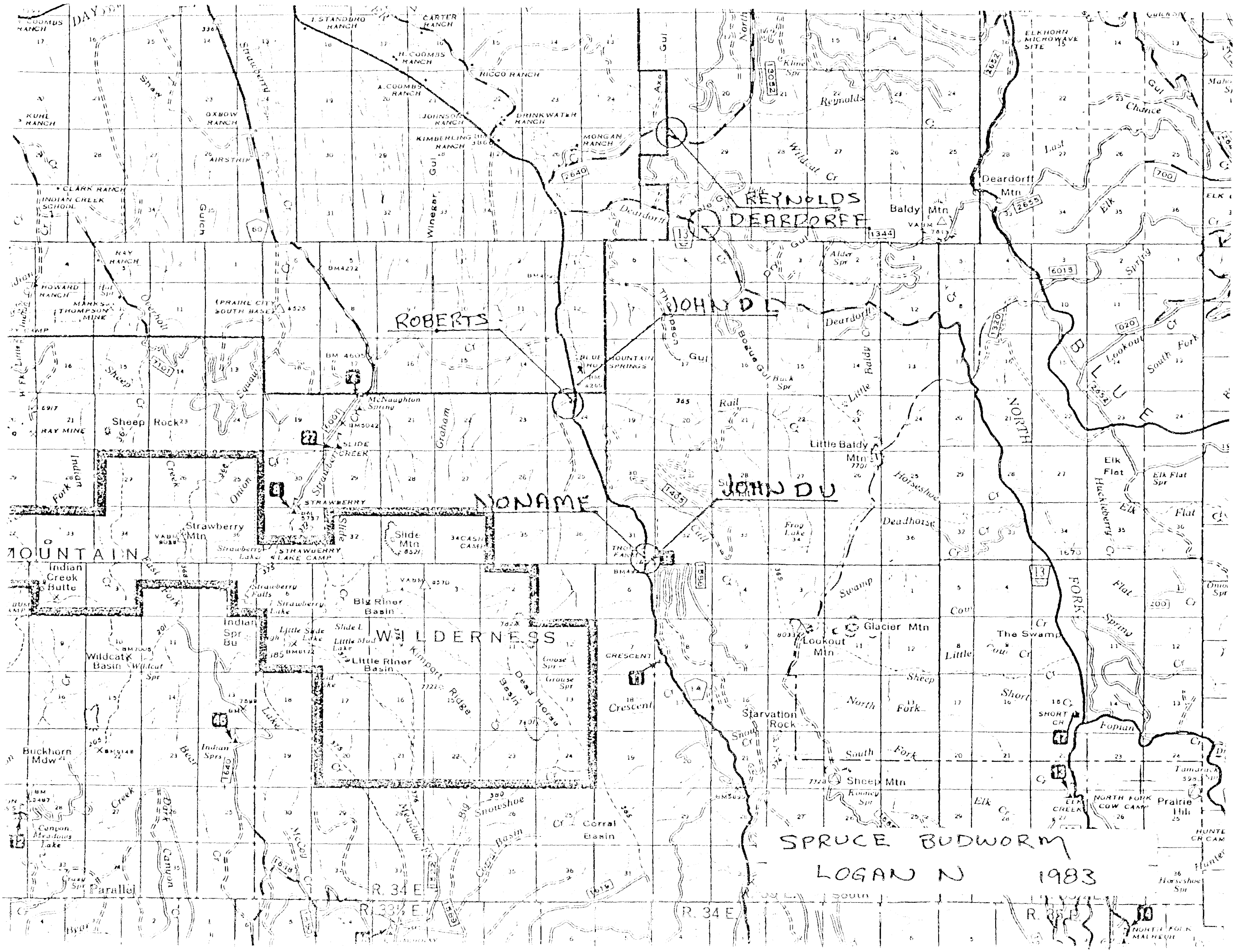
ANIMAL CODE	SCIENTIFIC NAME
PTE	*Pteronarcella badia*
YOR	*Yoroperla brevis*
AMP	*Amphinemura*
NEM	*Nemoura*
VIS	*Visoka*
ZAP	*Zapada*
PAR	*Paraleuctra*
ACR	Acroneuriinae
CAL	*Calineuria californica*
DOR	*Doroneuria*
PDE	Perlodidae
PDN	Perlodinae
ARC	*Arcynopteryx*
ISO	*Isoperla*
ISP	*Isoperla petersoni*
CHL	Chloroperlinae

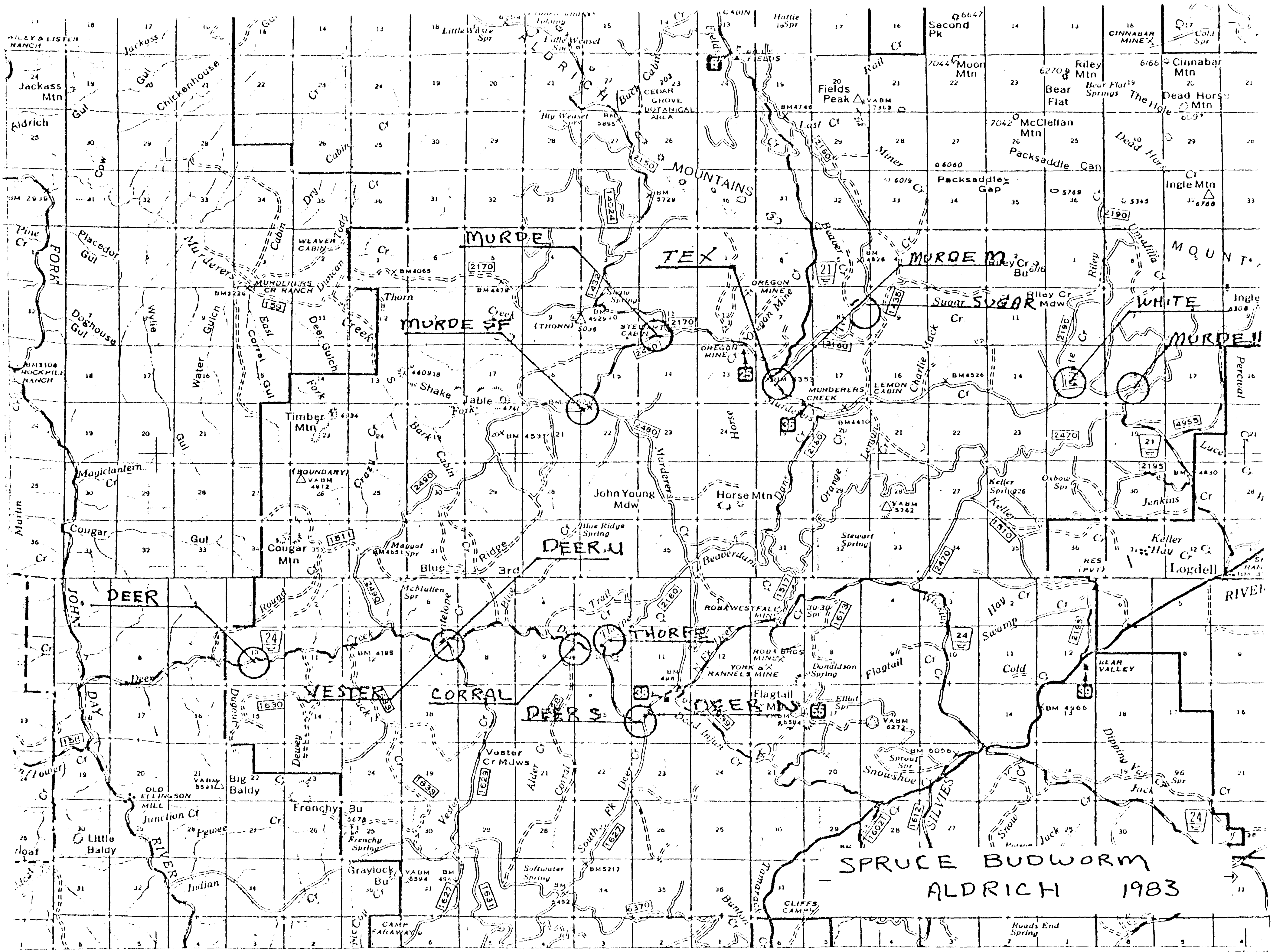
TABLE 3: PLECOPTERA LARVA IDENTIFIED TO THE LOWEST POSSIBLE TAXON IN SELECTED BENTHIC SAMPLES, 1982 AND 1983 SPRUCE BUDWORM PROJECT SITES, MALHEUR AND UMATILLA NATIONAL FORESTS.

CREEK	DATE	YOR	AMP	MAL	VIS	ZAP	ZAO	PAR	PER	ACR	CAL	DOR	HES	SKW	ISO	CHL
ALDER	710		5													11
BIG BO	705				3			1		2	1	1	1			6
BULLY	625								3	1	4					
BULLY	1001															1
CAT	710		35													
COTTON	628														2	50
COTTON	709															14
DEARDO	703	1					2	13				11			13	8
DEEP	705							2							6	
JOHN D	710	1			2		4			6		14	3		1	17
LANE	627		20				4		4		4		6			20
LANE	705								1							1
LANE	1001													2		2
LICK	705						2		6		8		2		2	44
REYNOL	703	2			2				3							21
TEX	707			4		2			2	2						164
WOLF	629		2						9		15					137
WOLF	711							2	1	4						38

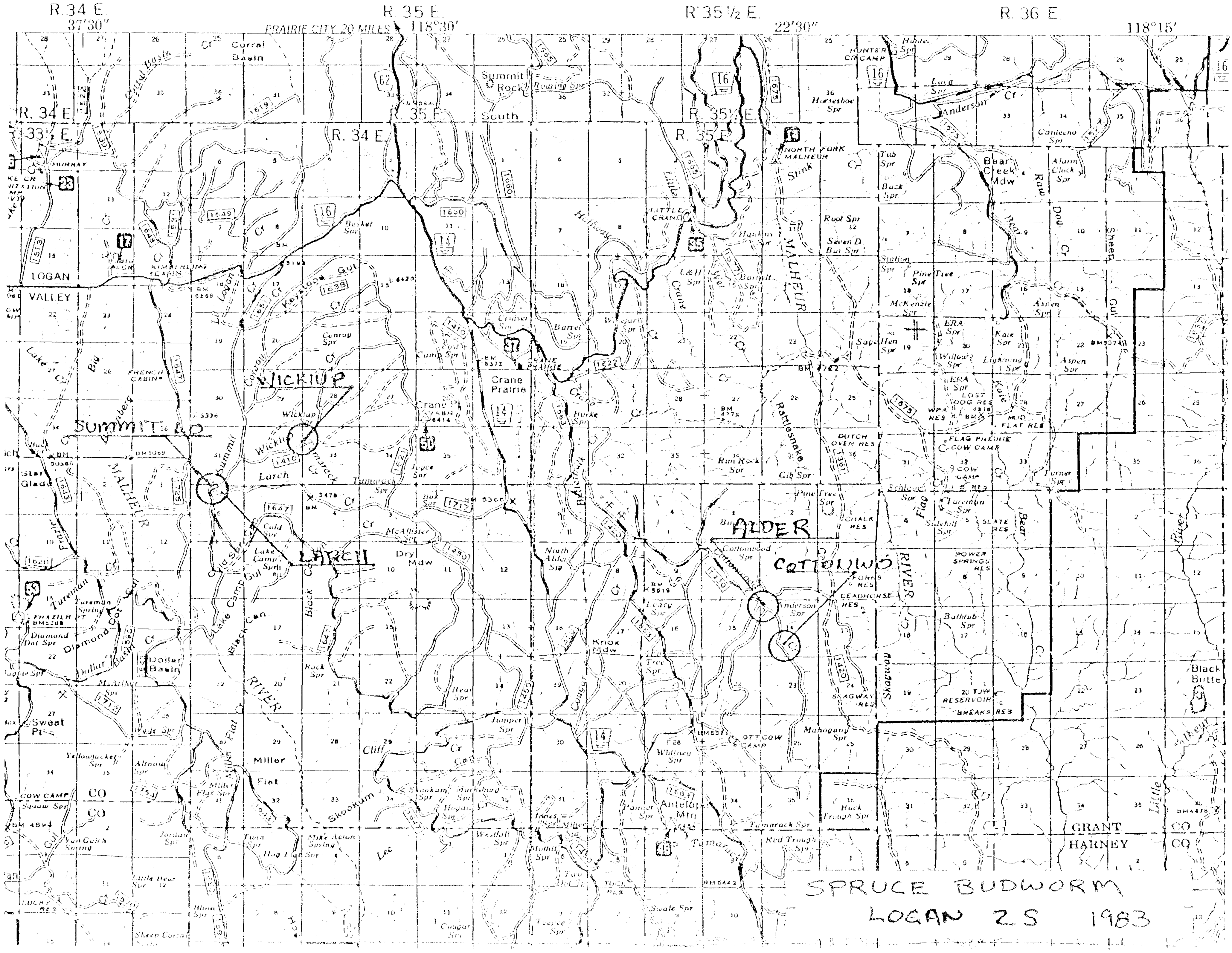
CODE	SCIENTIFIC NAME
YOR	*Yoraperla brevis*
AMP	*Amphinemura*
MAL	*Malenka*
VIS	*Visoka*
ZA	*Zapada*
ZAO	*Zapada oregonensis*
PAR	*Paraleuctra*
PER	Perlidae
ACR	Acroneuriinae
CAL	*Calineuria californica*
DOR	*Doroneuria*
HES	*Hesperoperla pacifica*
SKW	*Skwala*
ISO	*Isoperla*
CHL	Chloroperlinae

CODE	STREAM NAME
BIG BO	BIG BOULDER
COTTON	COTTONWOOD
DEARDO	DEARDORFF
JOHN D	JOHN DAY
REYNOL	REYNOLDS

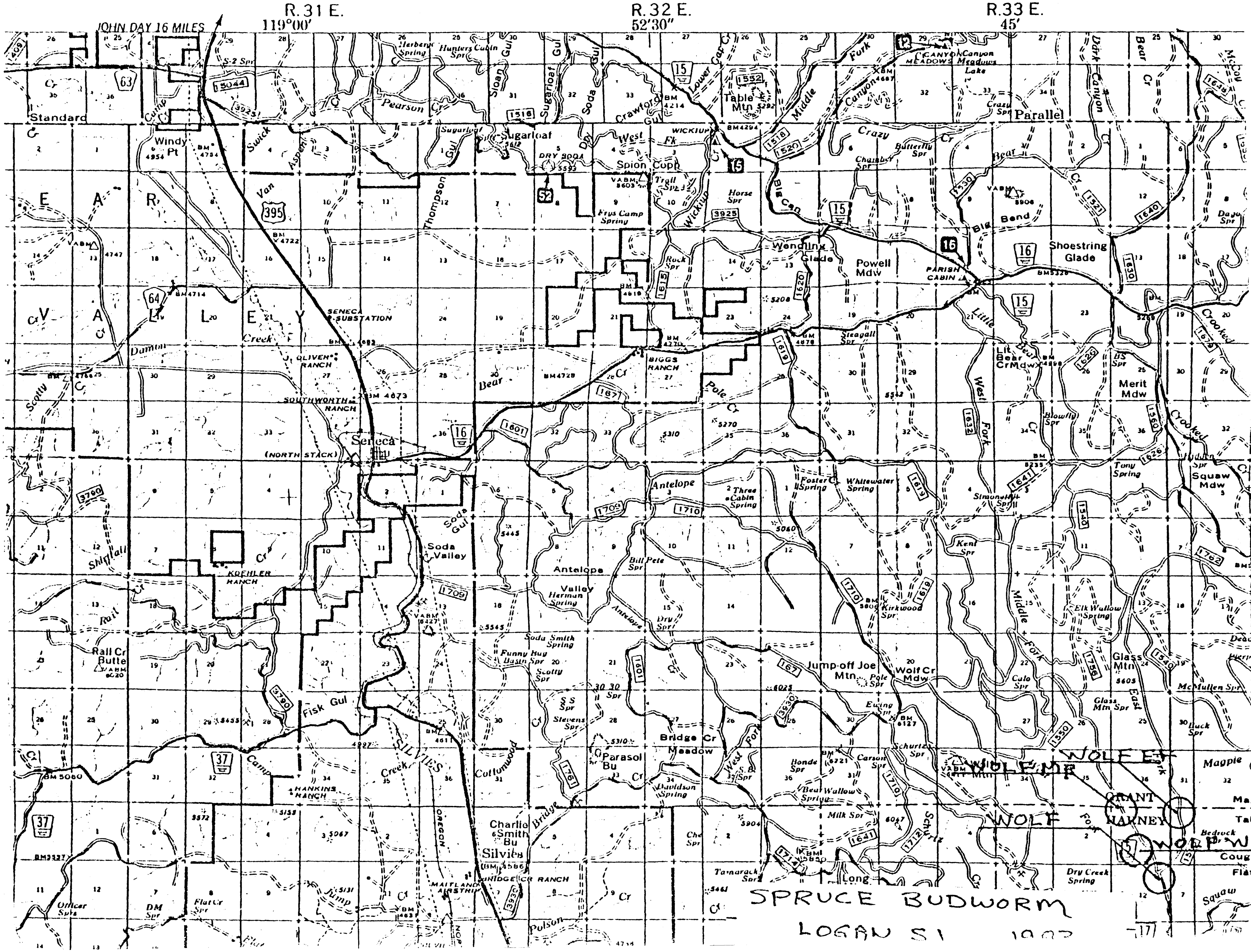

SPRUCE BUDWORM
LOGAN N 1983
REYNOLDS
DEARDORFF
JOHN D L
ROBERTS
NONAME
JOHN DU
CARTER RANCH
H. COOMBS RANCH
RICCO RANCH
A. COOMBS RANCH
JOHNSON RANCH
DRINKWATER RANCH
KIMBERLING RANCH
MORGAN RANCH
KUHL RANCH
OXBOW RANCH
AIRSTRIP
CLARK RANCH
INDIAN CREEK SCHOOL
RAY RANCH
HOWARD RANCH
THOMPSON MINE
PRAIRE CITY SOUTH BASE
RAY MINE
ELKHORN MICROWAVE SITE
Deardorff Mtn
Baldy Mtn
Reynolds
Chance
Wildcat Cr
BLUE MOUNTAIN HOT SPRINGS
McNaughton Spring
SLIDE CREEK
STRAWBERRY
Sheep Rock
Strawberry Mtn
Slide Mtn
CASH CAMP
STRAWBERRY LAKE CAMP
MOUNTAIN
Indian Creek Butte
Big River Basin
WILDERNESS
Little River Basin
Kimport Ridge
Dead Horse
Indian Spr Bu
Wildcat Basin
Buckhorn Mdw
Canyon Meadows Lake
Parallel
Little Baldy Mtn
Horseshoe
Deadhorse
Frog Lake
Swamp
Glacier Mtn
Lookout Mtn
CRESCENT
Crescent
Starvation Rock
Sheep Mtn
North Fork
South Fork
Elk Flat
Huckleberry
The Swamp
SHORT CR
NORTH FORK COW CAMP
Prairie Hill
NORTH FORK MALHEUR
Corral Basin
Snowshoe
NORTH
FORK
BLUE
R. 34 E.
R. 33½ E.
R. 35 E.



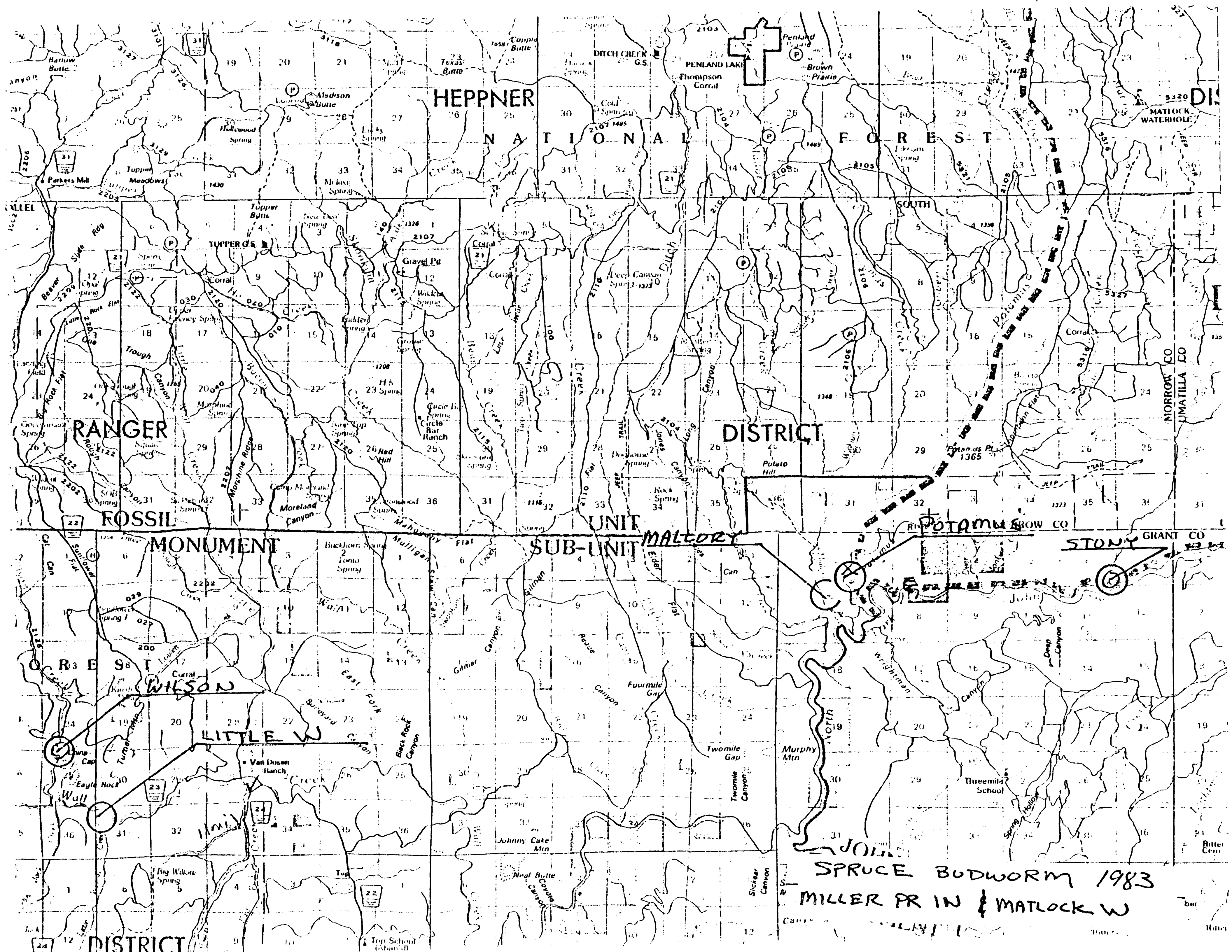
...ed in the Regional Office, Portland, Oregon in 1956 from U.S. Forest ... planimetric series and U.S. Geological Survey quadrangles



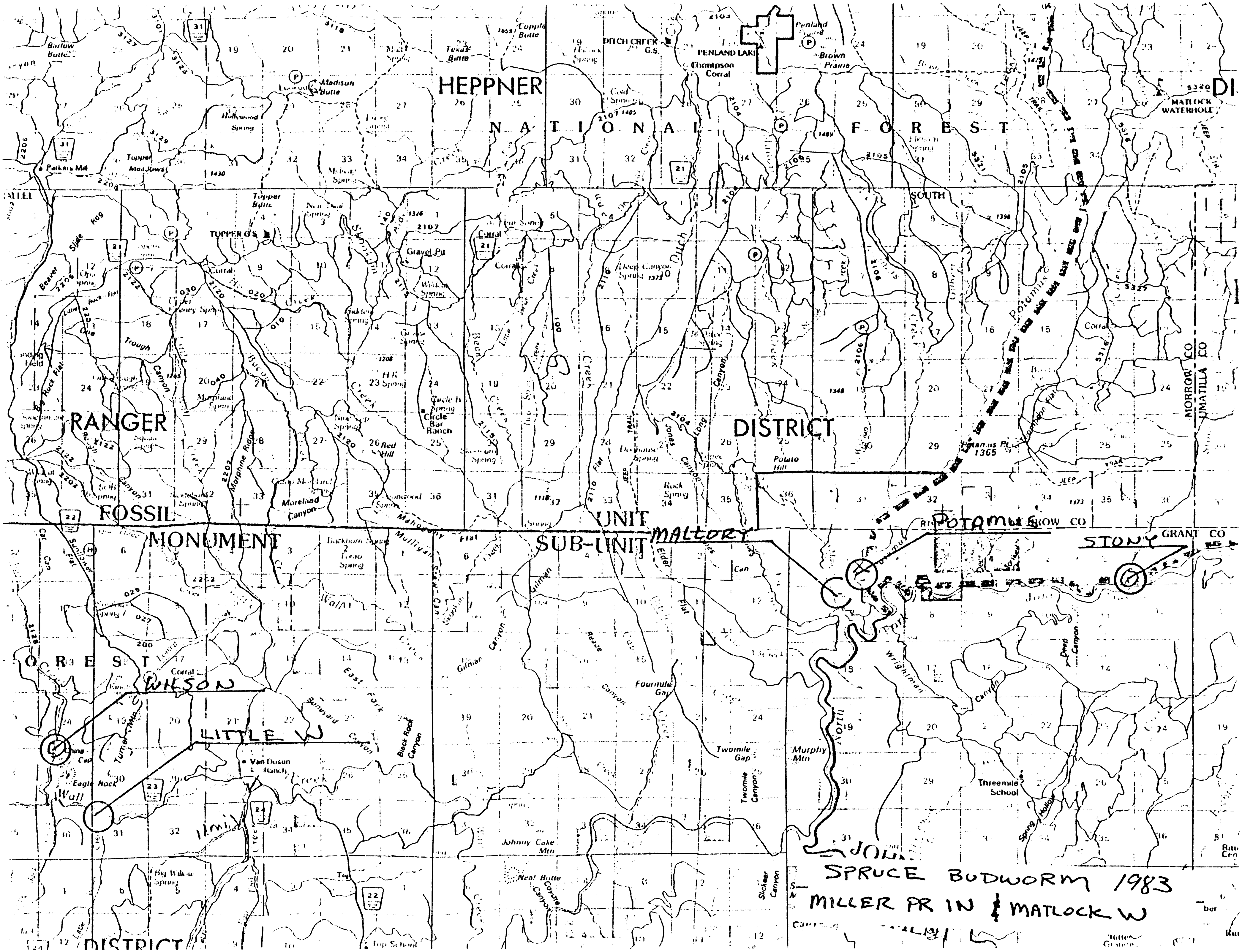
R. 34 E.
R. 35 E.
R. 35½ E.
R. 36 E.
PRAIRIE CITY 20 MILES
118°30′
118°15′
37′30″
22′30″
Corral Basin
Summit Rock
South
LOGAN
VALLEY
Crane Prairie
NORTH FORK MALHEUR
MALHEUR
Bear Creek Mdw
WICKIUP
SUMMIT LO
LARCH
ALDER
COTTONWO
Star Glade
Dollar Basin
Sweat Pt
Miller Flat
Knox Mdw
Antelope Mtn
Dry Mdw
Skookum
RIVER
Black Butte
GRANT CO
HARNEY CO
SPRUCE BUDWORM
LOGAN 2S 1983



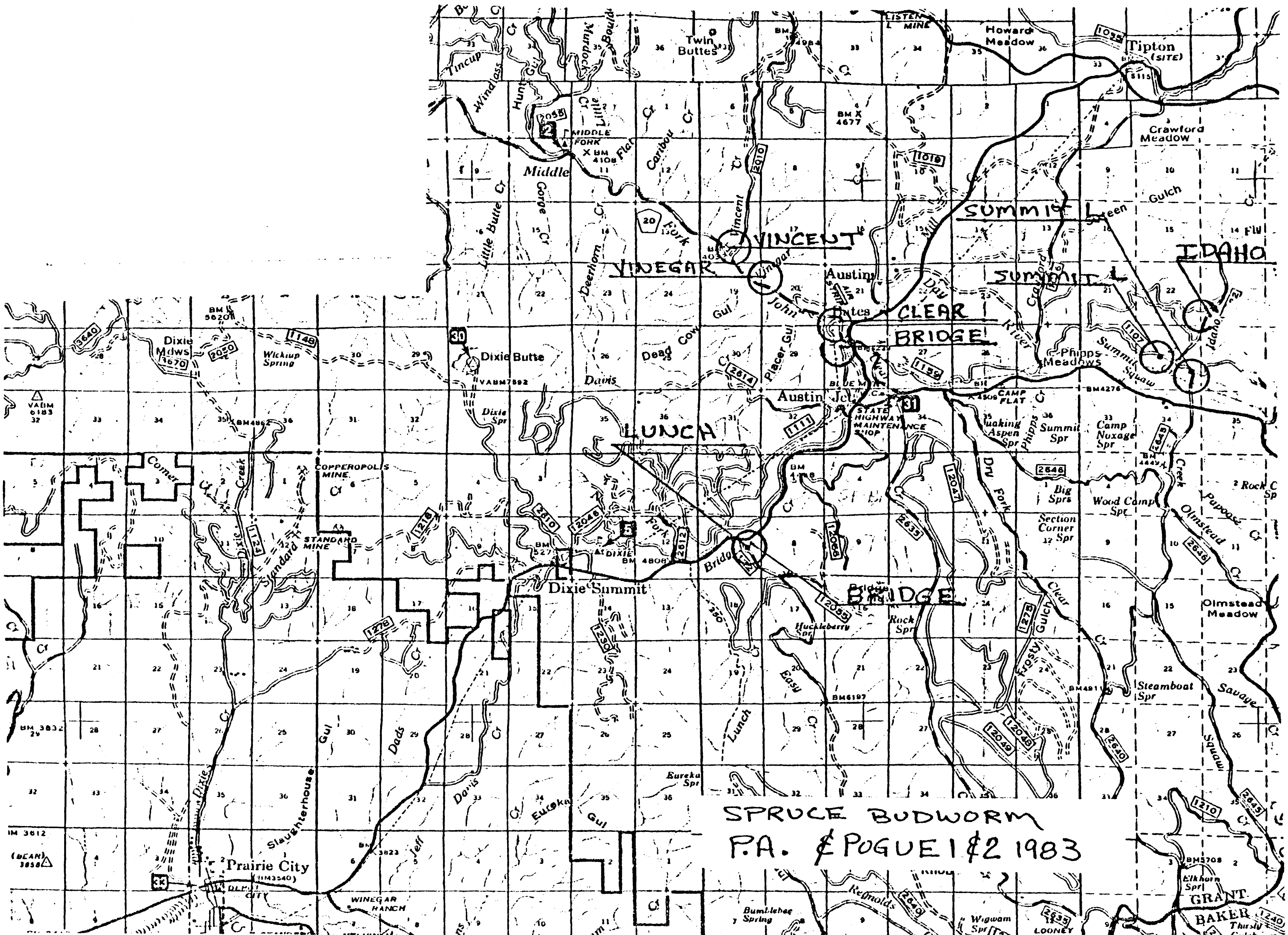
R. 31 E.
R. 32 E.
R. 33 E.
119°00′
52′30″
45′
JOHN DAY 16 MILES
Standard
Windy Pt
Swick
Aspen
Pearson Cr
Sugarloaf
Spion Copp
Crawford Gul
Table Mtn
Middle Fork
Canyon Meadows
Canyon Meadows Lake
Parallel
Crazy Cr
Bear Cr
Van
395
Thompson
Frys Camp Spring
Horse Spr
Big Can
Big Bend
Shoestring Glade
Wendling Glade
Powell Mdw
PARISH CABIN
SENECA SUBSTATION
OLIVER RANCH
SOUTHWORTH RANCH
BIGGS RANCH
Bear Cr
Pole Cr
Steagall Spr
Little Bear
Lit Bear Cr Mdw
Merit Mdw
Crooked
Damon Creek
Scotty Cr
Seneca
(NORTH STACK)
Antelope
Three Cabin Spring
Foster Spring
Whitewater Spring
Tony Spring
Squaw Mdw
Soda Gul
Soda Valley
Antelope Valley
Herman Spring
Bill Pete Spr
Kent Spr
Kirkwood Spr
Middle Fork
Elk Wallow Spring
Shingle
Rail Cr
KOEHLER RANCH
Rail Cr Butte
Soda Smith Spring
Funny Bug Basin Spr
Scotty Spr
30 30 Spr
Jump-off Joe Mtn
Pole Spr
Wolf Cr Mdw
Glass Mtn
Glass Mtn Spr
McMullen Spr
Calo Spr
Fisk Gul
SILVIES
Creek
Cottonwood
Stevens Spr
Parasol Bu
Bridge Cr Meadow
West Fork
Ewing Spr
Schurtz Spr
Carson Spr
Honde Spr
Bear Wallow Spring
Davidson Spring
Duck Spr
Magpie
Camp
HANKINS RANCH
Charlie Smith Bu
Silvies
BRIDGE CR RANCH
MAITLAND AIRSTRIP
OREGON
Milk Spr
Tamarack Spr
Long
Dry Creek Spring
Bedrock
Cougar
Squaw
Officer Spis
DM Spr
Flat Cr Spr
Jump
Polson
WOLF MF
WOLF EF
GRANT
HARNEY
WOLF
SPRUCE BUDWORM
LOGAN S1



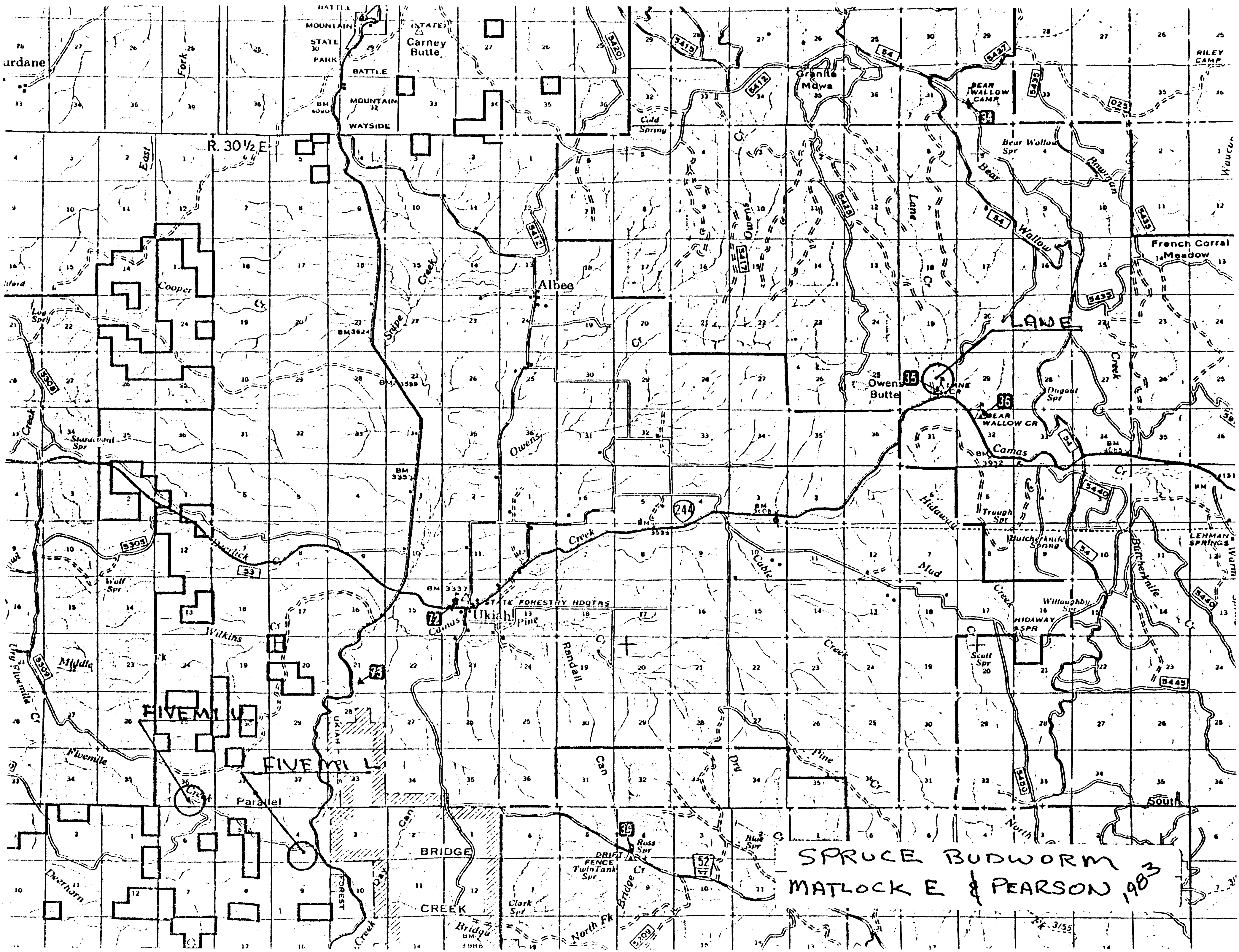
HEPPNER
NATIONAL FOREST
RANGER
DISTRICT
FOSSIL
MONUMENT
UNIT
SUB-UNIT
DISTRICT
MALLORY
POTAMUS
STONY
WILSON
LITTLE W
MORROW CO
UMATILLA CO
GRANT CO
MATLOCK WATERHOLE
PENLAND LAKE
DITCH CREEK G.S.
TUPPER G.S.
Potamus Pt 1365
Van Dusen Ranch
Johnny Cake Mtn
Murphy Mtn
Threemile School
SPRUCE BUDWORM 1983
MILLER PR IN & MATLOCK W

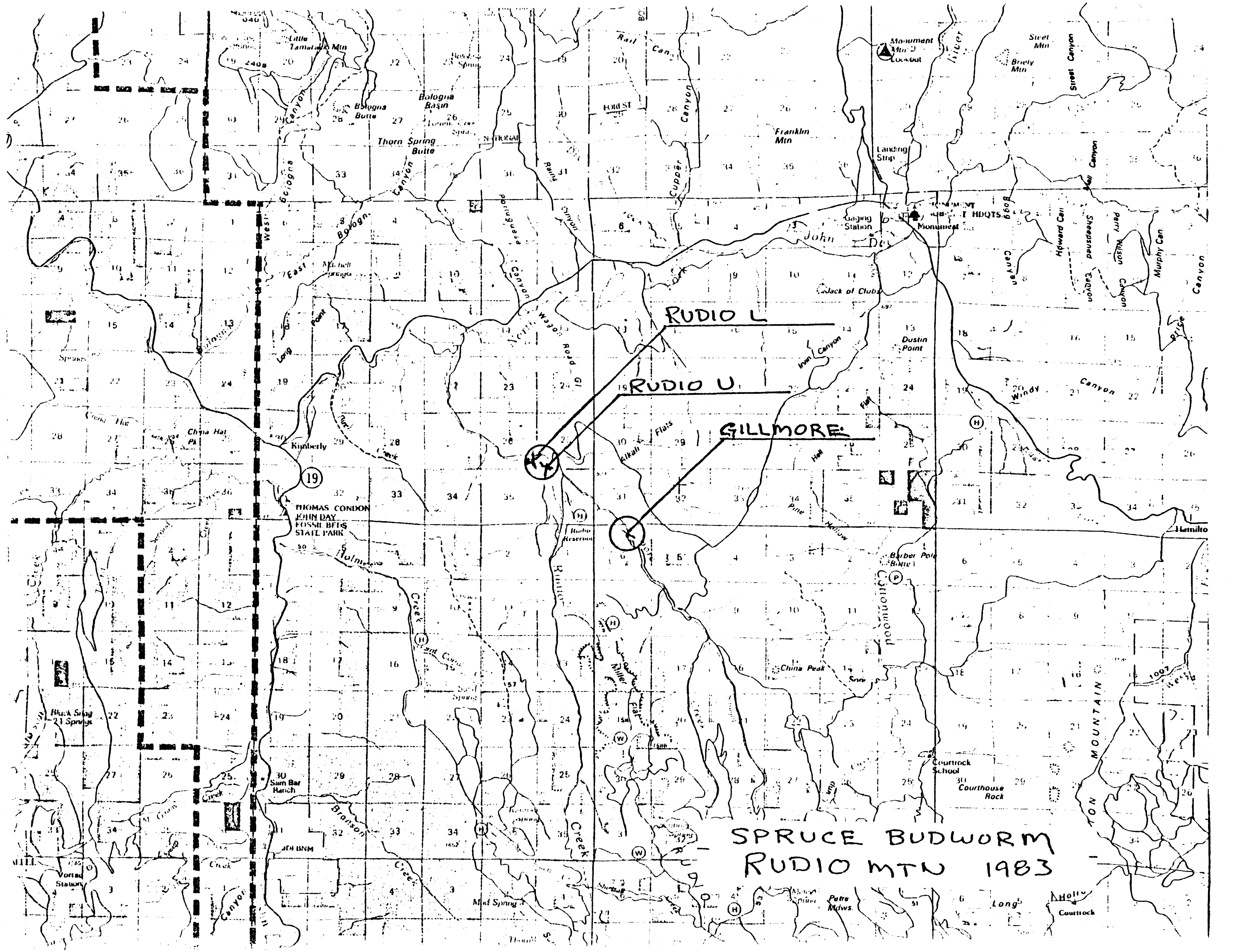


HEPPNER
NATIONAL
FOREST
RANGER
DISTRICT
FOSSIL
MONUMENT
UNIT
SUB-UNIT
MALLORY
POTAMUS
STONY
WILSON
LITTLE W
MORROW CO
UMATILLA CO
GRANT CO
Penland Lake
Ditch Creek G.S.
Thompson Corral
Brown Prairie
Matlock Waterhole
Madison Butte
Texas Butte
Copple Butte
Parkers Mill
Tupper Meadows
Tupper Butte
Tupper G.S.
Gravel Pit
Circle Bar Ranch
Potamus Pt
Potato Hill
Rock Spring
Moreland Canyon
Morphine Ridge
Mahogany Flat
Gilman Canyon
Fourmile Gap
Twomile Gap
Twomile Canyon
Murphy Mtn
Wrightman Canyon
Deep Canyon
Threemile School
Spring Hollow
Johnny Cake Mtn
Neal Butte
Slickear Canyon
Black Rock Canyon
Van Dusen Ranch
Eagle Rock
Big Willow Spring
Top School
Boneyard
East Fork
SPRUCE BUDWORM 1983
MILLER PR IN & MATLOCK W



SPRUCE BUDWORM
P.A. & POGUE 1&2 1983
VINCENT
VINEGAR
SUMMIT L
SUMMIT L
IDAHO
CLEAR
BRIDGE
LUNCH
BRIDGE
Tipton (SITE)
Howard Meadow
Twin Buttes
Crawford Meadow
Middle Fork
Austin
Bates
Phipps Meadows
Austin Jct.
State Highway Maintenance Shop
Camp Flat
Dixie Mdws
Dixie Butte
Wickiup Spring
Copperopolis Mine
Standard Mine
Dixie Summit
Huckleberry Spr
Rock Spr
Quaking Aspen Spr
Summit Spr
Camp Nuxage Spr
Big Sprs
Wood Camp Spr
Section Corner Spr
Olmstead Meadow
Steamboat Spr
Eureka Spr
Prairie City
Winegar Ranch
Bumblebee Spring
Wigwam Spr
Elkhorn Spr
GRANT
BAKER


SPRUCE BUDWORM
MATLOCK E & PEARSON 1983
LANE
FIVEMILE
FIVEMI L
BATTLE MOUNTAIN STATE PARK
Carney Butte
BATTLE MOUNTAIN WAYSIDE
R. 30 1/2 E.
Granite Mdws
BEAR WALLOW CAMP
RILEY CAMP
Cold Spring
Bear Wallow Spr
French Corral Meadow
Albee
Cooper Cr
Snipe Creek
Owens Butte
LANE CR
BEAR WALLOW CR
Dugout Spr
Camas Cr
Trough Spr
Butcherknife Spring
LEHMAN SPRINGS
Hidaway
Mud Creek
Willoughby Spr
HIDAWAY SPR
Scott Spr
Ukiah
STATE FORESTRY HDQTRS
Camas Creek
Pine Cr
Randall Cr
Cable Creek
Owens Cr
Wilkins Cr
Middle
Dry Fivemile Cr
Fivemile Creek
Parallel
Wolf Spr
Overlick Cr
Log Spr
Stardeaut Spr
UKIAH
BRIDGE CREEK
Can
Dry
North Fk
Bridge Cr
Deerborn
Ross Spr
DRIFT FENCE
TwinTank Spr
Blue Spr
Clark Spr
South
North
Oak
FOREST
Owens
Lane Cr
Bear Wallow
Bowman
Creek


RUDIO L
RUDIO U
GILLMORE
SPRUCE BUDWORM
RUDIO MTN 1983
Monument Mtn Lookout
Little Tamarack Mtn
Bologna Butte
Bologna Basin
Thorn Spring Butte
Franklin Mtn
Landing Strip
Gaging Station
Monument
Jack of Clubs
Dustin Point
Kimberly
China Hat
THOMAS CONDON JOHN DAY FOSSIL BEDS STATE PARK
Alkali Flats
Pine Hollow
Barber Pole Butte
Cottonwood
China Peak
Courtrock School
Courthouse Rock
Black Snag
Sam Bar Ranch
Petre Mdws.
Courtrock

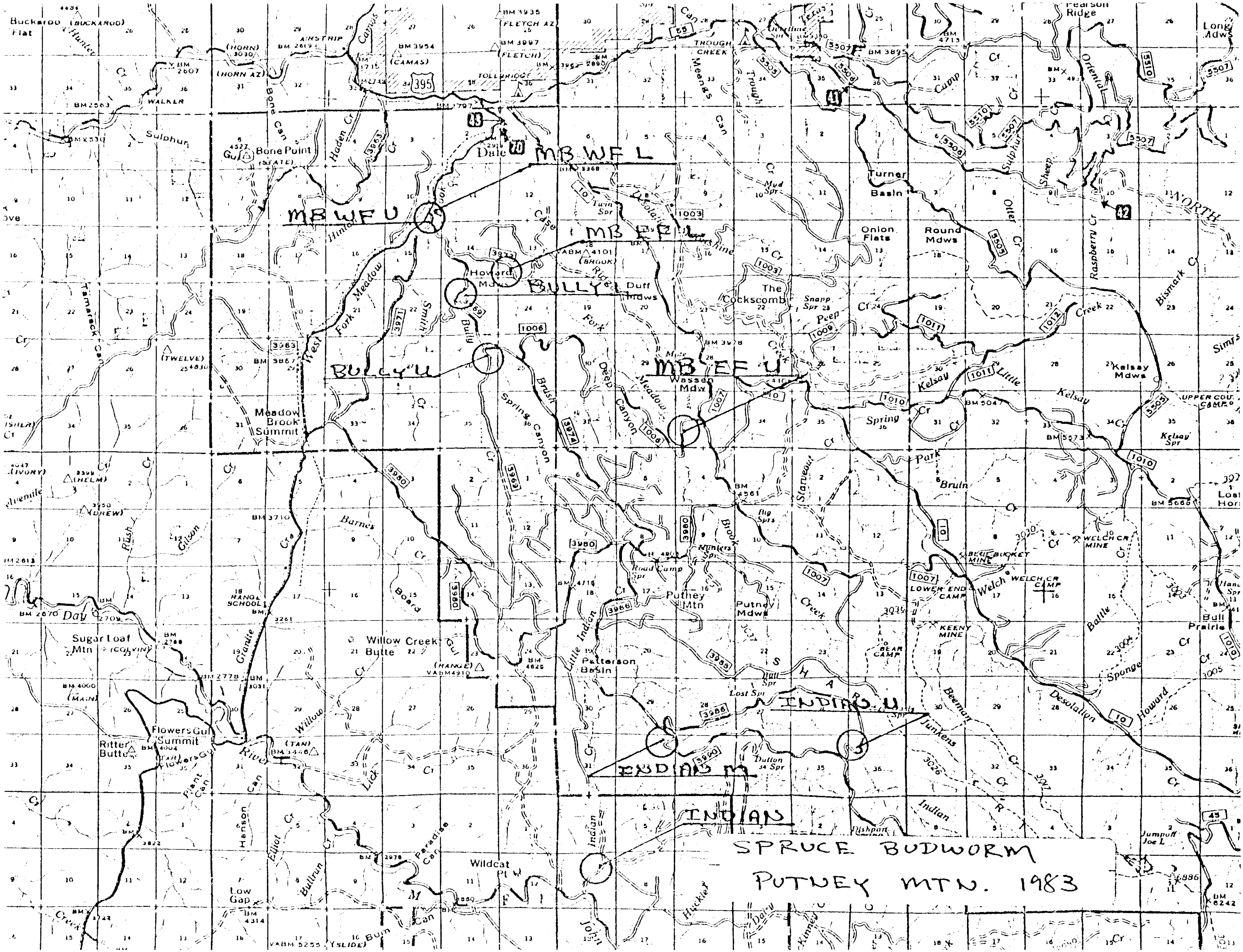

SPRUCE BUDWORM
PUTNEY MTN. 1983
MBWFL
MBWFU
MBEFL
BULLY
BULLY U
MB EF U
INDIAN U
INDIAN M
INDIAN
Buckaroo Flat
Bone Point
Dale
Meadow Brook Summit
Howard Mdws
Duff Mdws
Wasson Mdw
The Cockscomb
Onion Flats
Round Mdws
Turner Basin
Kelsay Mdws
Putney Mtn
Putney Mdws
Patterson Basin
Willow Creek Butte
Sugar Loaf Mtn
Flowers Gul Summit
Ritter Butte
Wildcat Pt
Low Gap
Bull Prairie
Pearson Ridge
Lower End Camp
Welch Cr Camp
Blue Bucket Mine
Keeny Mine
Range School
Desolation
Spring Canyon
Deep Canyon
Little Indian
Day
River
Grande

TABLE 6: NUMBERS OF AQUATIC ORGANISMS FOUND IN BENTHIC SAMPLES IN FOUR CREEKS ASSOCIATED WITH THE 1983 SPRUCE BUDWORM SPRAY PROJECT ON THE MALHEUR NATIONAL FOREST. COLLECTION DATE: SEPTEMBER 29, 1983, BY BRADY GREEN, U.S. FOREST SERVICE.

TAXA	CAT	ALDER	COTTON	COW	COW A	COW B	COW C
EPHEMOPTERA							
SIPHLONURIDAE	21						
BAETIDAE		22	147	95	77	6	12
HEPTAGENIIDAE	110	61	60				
EPHEMERELLIDAE	1167	1159	127	2899	2636	84	179
TRICORYTHIDAE	1						
PLECOPTERA							
Zapada cinctipes		1					
CHLOROPERLINAE		23	2	1		1	
HEMIPTERA							
GERRIDAE				1		1	
TRICHOPTERA							
HYDROPSYCHIDAE	1		82	2		1	1
BRACHYCENTRIDAE			1				
LEPIDOSTOMATIDAE	2	22					
LIMNEPHILIDAE	5		1	3	1	1	1
ODONTOCERIDAE				6	1	2	3
COLEOPTERA							
DYTISCIDAE				5	1	3	1
ELMIDAE			86				
DIPTERA							
TIPULIDAE	2	23	23	1	1		
PSYCHODIDAE			40				
CHIRONOMIDAE	58	66	372	298	194	24	80
DIXIDAE	1						
SIMULIIDAE	2	197		54	25	9	20
EMPIDIDAE		1		1	1		
MISCELLANEOUS							
NEMATODA		1		2			2
PLANORBIDAE				100	51	1	48
PHYSIDAE		22		44	25	3	16

APPENDIX E

Observations Related to the Effects of Carbaryl or Mexacarbate on the Behavior of Aquatic Invertebrates or the Quality of Water.

The following observations of aquatic invertebrates were made by Gene Silovsky and Bill Hansen on streams oversprayed with carbaryl and mexacarbate. Both insecticides are carbamates and result in the same or similar behavioral responses. These are some of the most common animals present in all streams.

Case Building Caddis Larvae: Larvae become inactive and withdraw into their case at lower carbaryl concentrations. When high concentrations of carbaryl are in a stream caddisflies leave their cases on the stream bottom and drift downstream. Some of the empty cases could also be seen drifting downstream. Their "light colored bodies" make them very observable. Carbaryl or mexacarbate at low concentrations disoriented individuals causing them to move awkwardly along the stream bottom or fall while climbing rocks in the stream.

Cranefly Lavae: These larvae are seldom seen on top of the stream substrate under normal conditions. They inhabitat the slower areas of streams with a high precentage of fines in the substrate. Carbaryl in the stream caused larvae to emerge from the substrate and tumble along the stream bottom. Often they were found near or moving toward the stream's bank.

Free Living Caddis: Larvae release their holds on the substrate/nets they have attached themselves to and begin drifting downstream as insecticide concentrations increase. Their "light-colored bodies" make them visable as they drift.

Stonefly and Mayfly Larvae: Larvae release their holds on the substrate and tumble down stream throughout the water column from insecticide exposure. Their lighter ventral surface makes them more visible as they tumble, but some species and stages of development are difficult to see.

Waterstridders and Beetles: Adults of these animals live in large part on the water surface or have the ability to remove themselves from contaminated water, i.e., most beetles can fly. It was not uncommon to find large numbers of live water stridders and beetles in streams that also contained numerous dead mayflies, caddisflies, and stoneflies. It also appears they have a higher rate of tolerance for these insecticides.

Planaria: Common to abundant in most streams within the project area large numbers of these animals were still present in streams such as Cat and Alder several days after they received a heavy overspray. It appears they have a high tolerance for carbaryl.

Determining if Carbaryl or Mexcarbate Entered the Stream.

1. One of the components of the Sevin-4-oil mixture was latex. This gave the insecticide a white/cream coloration. Spray deposits from aerial application are readily observable on rocks and vegetation as white/cream colored speckling.

2. Zectran (mexacarbate) used in the 1983 project was colored with a red or green dye. Spray deposits on vegetation and rocks was extremely difficult to see. Spray cards are usually necessary to detect deposits of Zectran.

3. The appropriate types of spray cards placed adjacent to the stream will help quantify the amount of spray deposited.

4. Observations of the stream environment for dead and distressed insects can be made in these ways. (a) Watching an area of the stream water column for drifting dead or distressed insects; (b) Searching detritus collection areas of the stream, usually near shore, rather then in the middle of the stream, for dead or distressed aquatic insects; (c) Checking to see if budworm larvae are streaming down from adjacent trees. Often numerous terrestrial insects, including budworm larvae will be seen while engaged in Items a and b; and (d) the presence of an oil film or unusual foam on the water surface and cloudiness of the water.

APPENDIX F

Water Monitoring Information

Pogue Point 2

Pesticide (mexacarbate) treatment of Pogue Point 2 occurred on June 24 & 25, July 4 & 5, 1983. Poor weather conditions (rain and winds) from June 27 to July 3 delayed treatment of parts of Summit Creek and all of the Idaho drainage. The area treated on June 24, 1983, did not have dye added to the mixture. Approximate location of daily treatment areas and sampling sites is presented in Figure 1. Tables 1 and 2 present all information collected from dye analysis of water samples for Summit and Idaho Creeks.

Block 5 from Figure 1 was not treated with dyed mexacarbate (Zectran DB), Block 4 was treated with an insecticide to dye (Rhodamin BT - 35% in oleic acid) ratio of 162:1 while Blocks 1, 2, and 3 contained a ratio of 103:1. The normal mix ratio is 50:1.

Of the over 128 water samples analyzed for dye traces in the Summit Creek drainage, none contained substantial levels of dye with only four samples suggesting mexacarbate concentrations in the range of 1-4 ppb. Observations indicated at mayflies and caddisflies were under some stress within the unit.

Aquatic insect drift sampling did not indicate an increase in the post treatment samples. Benthic populations were somewhat lower in the post

spray samples but the substrate was not uniform being a narrow mud, rock, and gravel channel. The area received heavy impacts to the stream and banks from grazing cows.

The Idaho Creek area was treated on July 4 and 5, 1983, with mexacarbate (.125 lb/acre) and fluorescent tracer (Figure 1). None of the 80 samples collected indicated more than traces of dye (Table 2). Representative aquatic insect drift and benthic sampling was difficult due to the grazing cows and the non-uniform channel conditions similar to Summit Creek.

Slight effects were found from the use of mexacarbate (Zectran). Increased care in observation and application may have helped reduce any impacts. The lower application rate per acre is also an important reason to expect lower concentrations in streams and impacts to aquatic organisms.

APPENDIX F

Table 1
Water Sample Results from
Dye Tracer Collections in Summit (Pogue Point 2)

Location	Type Sample	Sample Date	& Time	Approximate Dye Concentration (ppb) 1/	Estimated Pesticide Concentration (ppb)
		Treatment 6/25/83			
Summit, upper	Grab	6/25/83	0816	0	
	"		1110	0	
	"		1450	T	
	Grab	6/26/83	0655	0	
Summit, lower	Grab	6/25/83	0527	0	
	"		0807	0	
	"		1045	0	
	"		1350	0	
	ISCO 2/		1430	0	
	Grab		1435	0	
	ISCO		1500	0	
	"		1530	0	
	"		1600	0	
	"		1630	0	
	"		1700	0	
	"		1730	0	
	"		1800	0	
	"		1830	0	
	"		1900	0	
	"		1930	0	
	"		2000	0	
	"		2030	0	
	"		2100	0	
	"		2130	0	
	"		2200	0	
	"		2230	0	
	"		2300	0	
	"		2330	0	
	"		2400	0	
	ISCO	6/26/83	0030	0	
	"		0100	0	
	"		0130	0	
	"		0200	0	
	"		0230	0	
	"		0300	0	
	"		0330	0	
	"		0400	0	
	"		0430	0	
	"		0600	0	

Location	Type Sample	Sample Date &	Time	Approximate Dye Concentration (ppb) 1/	Estimated Pesticide Concentration (ppb)
S.F. Summit	Grab	6/25/83	1504	0	
Summit above helispot	Grab	6/25/83	0900	.01	1-2
Summit by helispot	Grab	6/25/83	0853	T	
Summit below helispot	Grab	6/25/83	0850	.016	2-3
S.F. Summit at Powerline	Grab	6/25/83	0811	.01	1-2
	"		1050	0	
Summit by Meadow Road	Grab	6/25/83	0907	0	
Skunk Pond	Grab	6/25/83	0915	.02	3-4
Cr. by Highway near powerline	Grab	6/25/83	1007	T	
Creek at 2622 Hwy.	Grab	6/25/83	1037	T	
Summit Cr. at Wood Camp	Grab	6/25/83	1130	.01	1-2
Upper end Summit Meadow	Grab	6/25/83	1140	0	
		Treatment 7/4 & 5/83			
Summit, Lower	Grab	7/4/83	0548	0	
	"		0600	0	
	ISCO		0630	0	
	"		0715	0	
	Grab		0720	0	
	ISCO		0800	0	
	Grab		0815	0	
	ISCO		0845	0	
	"		0930	0	
	"		1015	0	
	"		1100	0	
	"		1145	0	
	"		1230	0	
	"		1315	0	
	"		1400	0	
	"		1445	0	
	"		1530	0	
	"		1615	0	
	"		1700	0	

Location	Type Sample	Sample Date & Time		Approximate Dye Concentration (ppb) 1/	Estimated Pesticide Concentration (ppb)
	ISCO		1745	0	
	"		1830	0	
	"		1915	0	
	"		2000	0	
	"		2045	0	
	"		2130	0	
	"		2215	0	
	"		2300	0	
	"		2345	0	
	ISCO	7/5/83	0030	0	
	"		0115	0	
	"		0200	0	
	"		0245	0	
	"		0440	0	
	"		0600	0	
	"		0630	0	
	"		0717	0	
	"		0730	0	
	Grab		0756	0	
	ISCO		0815	0	
	"		0900	0	
	"		0945	0	
	"		1030	0	
	"		1115	0	
	"		1200	0	
	"		1245	0	
	"		1330	0	
	"		1415	0	
	"		1500	0	
	"		1545	0	
	"		1630	0	
	"		1715	0	
	"		1800	0	
	"		1845	0	
	"		1930	0	
	"		2015	0	
	"		2100	0	
	"		2145	0	
	"		2230	0	
	"		2315	0	
	"		2400	0	
	ISCO	7/6/83	0045	0	
	"		0130	0	
	"		0215	0	
	"		0300	0	
	"		0345	0	

Location	Type Sample	Sample Date &	Time	Approximate Dye Concentration (ppb) 1/	Estimated Pesticide Concentration (ppb)
A Summit, upper	Grab	7/4/83	0825	0	
Summit 0.4 mile above A	Grab		0840	0	
Summit 0.8 mile above A	Grab		0845	0	
Summit 1.2 mile above A	Grab		0852	T	
Summit 1.6 mile above A	Grab		0857	T	
Summit 2.0 mile above A	Grab		0902	.01	1
Summit 2.4 mile above A	Grab		0914	T	
Summit 2.0 mile above A	Grab		0925	T	
Summit 2.0 mile above A	Grab		1126	T	
Summit 2.0 mile above A	Grab	7/5/83	0825	0	
N.F. Summit at Card Transect	Grab	7/4/83	0855	T	
N.F. Summit near Hawk Nest	Grab		0935	0	

1/ Recordings under 0.1 ppb dye are below the detection limits commonly used but may indicate a small amount of mexacarbate is present. T = Trace means dye concentration estimated at below 0.01 ppb and little confidence should be given to reading.

2/ ISCO represents a brand of programmable automatic water sampling devises.

APPENDIX F

Table 2
Water Sample Results from
Dye Tracer Collections in Idaho Creek

Location	Type Sample	Sample Date	& Time	Approximate Dye Concentration (ppb) 1/	Estimated Pesticide Concentration (ppb)
		Treatment 7/4 (a little) and 7/5/83			
Idaho Cr. (1)	Grab	7/4/83	0525	0	
	"		0630	0	
	"		0700	0	
	"		0752	0	
	ISCO 2/		0800	0	
	"		0845	0	
	"		0930	0	
	Grab		1000	0	
	ISCO		1015	0	
	"		1100	0	
	"		1145	0	
	"		1230	0	
	"		1315	0	
	"		1400	0	
	"		1445	0	
	"		1530	0	
	"		1615	0	
	"		1700	0	
	"		1745	0	
	"		1830	0	
	"		1915	0	
	"		2000	0	
	"		2045	0	
	"		2130	0	
	"		2215	0	
	"		2300	0	
	"		2345	0	
	ISCO	7/5/83	0030	0	
	"		0115	0	
	"		0200	0	
	"		0245	0	
	"		0330	0	
	"		0415	0	
	Grab		0541	0	
	"		0615	0	
	ISCO		0630	0	
	Grab		0700	0	
	ISCO		0715	0	
	Grab		0730	0	
	ISCO		0800	0	
	"		0845	0	
	Grab		0855	0	
	ISCO		0930	0	
	Grab		0938	0	
	ISCO		1015	0	
	"		1100	0	
	"		1145	0	

Location	Type Sample	Sample Date & Time		Approximate Dye Concentration (ppb) 1/	Estimated Pesticide Concentration (ppb)
Idaho Cr. (1)	ISCO		1230	0	
	"		1315	0	
	"		1400	0	
	"		1445	0	
	Grab		1517	0	
	ISCO		1530	0	
	"		1615	0	
	"		1700	0	
	"		1745	0	
	"		1830	0	
	"		1915	0	
	"		2000	0	
	"		2045	0	
	"		2130	0	
	"		2215	0	
	"		2300	0	
	"		2345	0	
	ISCO	7/6/83	0030	0	
	"		0115	0	
	"		0200	0	
	"		0245	0	
Other Sites (Idaho)					
0.4 mile above 1	Grab	7/4/83	1005	0	
0.8 mile above 1	"		1015	0	
1.2 mile above 1	"		1023	0	
1.6 mile above 1	"		1030	0	
1.9 mile above 1	"		1040	0	
1.9 mile above 1	"		0805	0	
Idaho Cr. at Lower Card Transect	Grab	7/5/83	1710	T	
Idaho Cr. at Upper Card Transect	Grab	7/5/83	1700	T	
Idaho 1.9 mile above 1	Grab	7/5/83	0820	0	
Idaho 0.4 mile above 1	Grab	7/5/83	0901	0	
Idaho 0.8 mile above 1	Grab	7/5/83	0910	0	

Location	Type Sample	Sample Date & Time		Approximate Dye Concentration (ppb) 1/	Estimated Pesticide Concentration (ppb)
Idaho 1.2 mile above 1	Grab	7/5/83	0919	0	
Idaho 1.9 mile above 1	Grab	7/5/83	0930	0	

1/ Recordings under 0.1 ppb dye are below the detection limits commonly used but may indicate a small amount of mexacarbate is present. T = Trace means dye concentration estimated at below 0.01 ppb and little confidence should be given to reading.

2/ ISCO represents a brand of programmable automatic water sampling devises.

Appendix G: Cottonwood Creek Drainage Spill Documentation

1983 Western Spruce Budworm Suppression Project
USDA, Forest Service
Oregon Department of Forestry
John Day, OR 97845

2540 Water Uses and Development

July 20, 1983

Cottonwood Creek Drainage - Logan South Two Overspray

Randy Perkins, Project Director

Enclosed is a map of the stream systems in the Cottonwood Creek drainage, which were accidently sprayed with Sevin on Friday, July 8. The data on the map is a composite of the following field observations:

7-8-83 Gene Silovsky USFS and Steve Pribyl ODFWL

7-9-83 Gene Silovsky, Bud Salisbury, and Brian Scaccia USFS

7-15-83 Gene Silovsky and Brady Green USFS

The detailed field notes of these observers are in the possession of Silovsky, Pribyl, or Green. No dead fish were found in the stream during their observations.

The criteria for the map legend were:

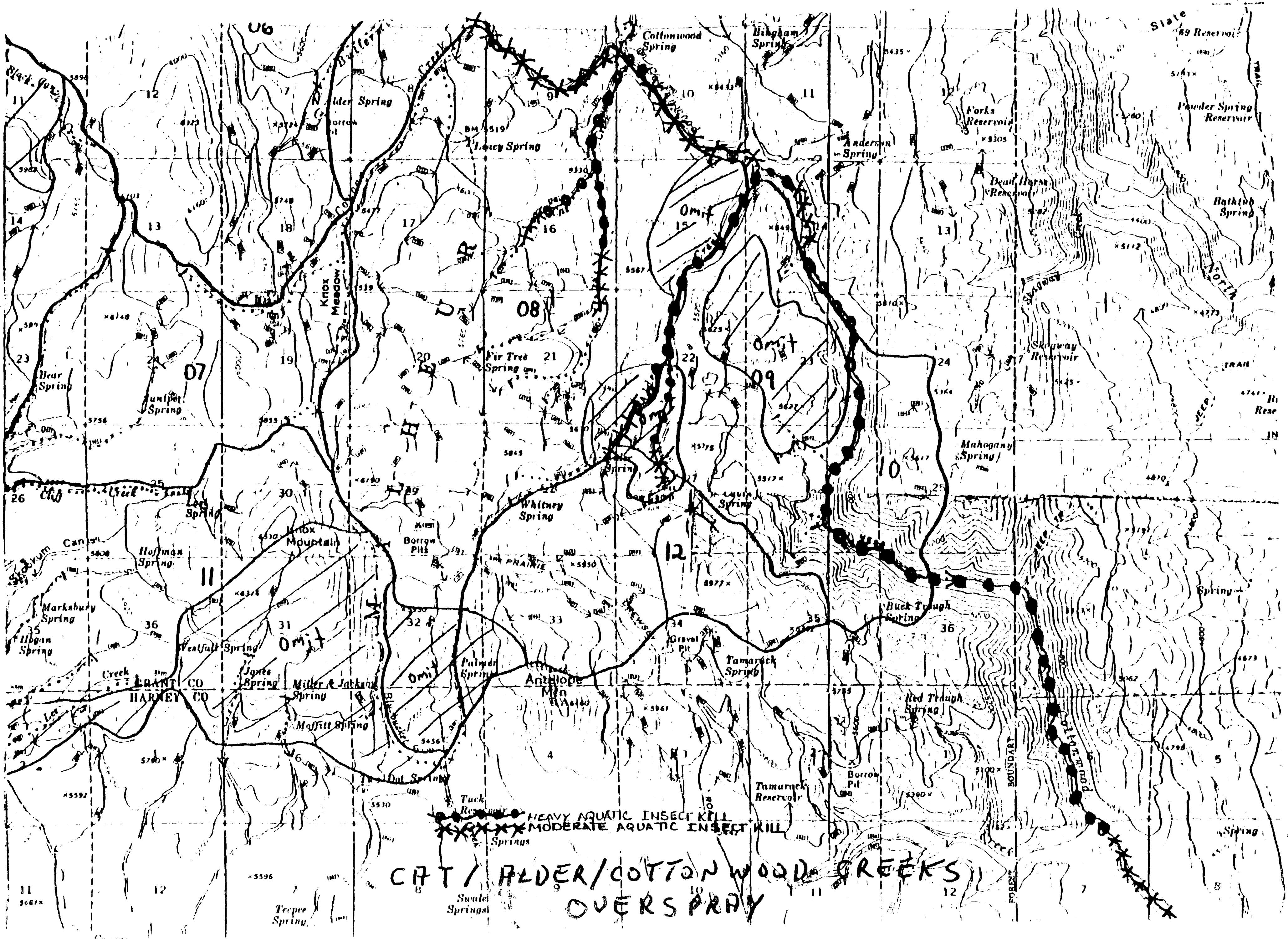
Red - 90% of aquatic insects killed. (1) Very heavy spray deposit on instream rocks, or (2) numerous dead mayfly, caddis fly, stonefly larvae evident or (3) few or no live caddis fly, stonefly, or mayfly evident on July 15, 1983. Often two or more of the above were observed at a check point.

Green - Aquatic insect kill moderate to heavy. Less than 50% aquatic insects killed, although some species "may be" totally eliminated. (1) Moderate to light spray deposit on rocks or (2) dead mayfly, caddis fly, and stonefly very evident on July 8 and 9, 1983, but live caddis and mayfly also fairly evident on July 8, 9 and 15, 1983.

GENE D. SILOVSKY
Assistant Environmental Monitor

Enclosure

cc: Bill Hosford, ODFWL, Hines;
Warren Current, Fishery and Wildlife Staff, Malheur NF
Bill Hansen
Gene Silovsky


HEAVY AQUATIC INSECT KILL
MODERATE AQUATIC INSECT KILL
Omit
07
08
09
10
11
12
Cottonwood Spring
Bingham Spring
Alder Spring
Lucy Spring
Anderson Spring
Forks Reservoir
Powder Spring Reservoir
Dead Horse Reservoir
Bathtub Spring
Knox Meadow
Fir Tree Spring
Bear Spring
Juniper Spring
Mahogany Spring
Skyway Reservoir
Whitney Spring
Borrow Pits
Knox Mountain
Hoffman Spring
Marksbury Spring
Buck Trough Spring
Gravel Pit
Tamarack Spring
Antelope Mtn
Palmer Spring
Jones Spring
Miller & Jackson Spring
Moffitt Spring
Red Trough Spring
Tamarack Reservoir
Borrow Pit
Tuck Reservoir
Swale Springs
Teepee Spring
GRANT CO
HARNEY CO
BOUNDARY
69 Reservoir
CAT/ALDER/COTTONWOOD CREEKS OVERSPRAY

APPENDIX H

WILLOW CREEK SPILL
INCIDENT REPORT

JUNE 13, 1983

0800 - Received a call at Rudio Creek area that here was an accident and spill involving a batch truck along Road 53 near Cutsforth Park, T.4S., R.28E., Sec. 27. We were told to leave immediately for the spill site. Gene Silovsky, Wildlife Biologist and Assistant Environmental Coordinator for the Spruce Budworm Project, and I took 5-10 minutes to locate the spill area and quickly finish brief discussions with the water monitoring contractor on the Spruce Budworm Project. We stopped in Kimberly, Oregon to pick up some ice and salt for water sample preservation and stream tracing if necessary.

0915 - Reached Tupper area and realized from looking at the maps on the way over that the situation may be very critical with Willow Creek so close to the road. We also noticed that all people at the heliport area were gone.

1000 - Reached spill site. We were horrified that the worst possible spill accident could have happened, a batch truck in the stream. The spill vacinity had apparently been limed but how heavily is unknown. We talked maybe 10 or 15 minutes with Ben Seminole, USFS District Ranger and Carl Martin, Sheriff's Dept. They indicated that the accident occurred about 0400-0430 hours. They indicated spill was observed at one mile below at 0745 and at 0815 1 mile below Cutsforth Park. The water in the spill area was still slightly milky to my recollection. As we left and drove downstream the following observations and mileages were recorded:

	Mileage	Observation
	60.3	Cutsforth Park-stream milky
	61.9	Milky Willow Creek
	63.0	Willow Creek not milky
	64.1	Stopped and looked at Willow Creek. Insects appeared alive at first glance.
1015 -	65.8	Went downstream to install first monitor location, get drift net installed before slug hits and took water samples. Noted caddis flies, stoneflies, and Mayflies still alive at 1020 hours.
	67.5	Picnic table area

72.7 Talked to Mrs. Lee Howard, PO Box 415, Heppner, Oregon, (503) 676-5042. I asked her if I could use her telephone and install some monitoring equipment in Willow Creek due to the spill upstream. She was unaware of the spill so we told her briefly what happened. I asked if the pond on the Harshman property was fed by the stream. She indicated she would call someone to find out and tell them about the spill.

1100 - Called Randall Perkins, Budworm Project Director, and briefly indicated to him the situation. I told him from the spill estimates I had made on the Siskiyou National Forest, that impacts would probably extend to the Columbia River unless something was done. I asked him about resident notification and he indicated OARS was notified and would notify residents to Heppner.
He indicated that my place was as a water monitor and consultant with no authority to direct or demand work. The Contractor was to accomplish the work and OARS was to direct necessary containment and clean-up actions.

1130 - Returned to Site 1 took water sample. Aquatic insects alive (Mayfly, etc.).

1138 - Stopped where a helicopter had landed and talked to two helicopter contractor personnel about what they were doing. They told us they installed a charcoal briquet (210 lbs.) dam with an oil collection boom across the channel which I think they obtained from the DEQ. Aquatic insects were alive still in Willow Creek. Gene and I talked about the rapid flow of the water through the briquets. Also I indicated that I thought activated charcoal should be used due to more absorption and greater surface area. Someone told the contractor personnel that briquets were just as good.

1200 - Installed drift net and took water sample at helicopter landing site (Site 3). Talked to Brett McKnight (DEQ) between 1200 and 1215 about our involvement in monitoring. He gave me his card but I was not sure of his responsibility at that time. Brett went to talk with Ron Terwilliger, the Contractor.

1220 - Ron Terwilliger and others came to Site 3 talking about installing more containment or absorption "dams". He seemed more than willing to do what was necessary, but he was unsure what to do. Gene and I recommended that they put any new structures in downstream. I briefly mentioned that the stream

could be dammed or a hole cut in the channel with a backhoe, so the water could be irrigated or somehow diverted onto dry land to promote filtering through the soil. I also, mentioned that straw, sawdust, or wood chips could be used to absorb chemicals. Some said hay bales were readily available so away they went to get some.

1225 - approx. Gene went upstream to collect information on pond, upstream situation, while I remained at Site 3 for slug to reach there.

1248 - Emptied drift net at Site 3. Substantial insect drift was noted minutes before. Add one 10" trout to total in net. Fish Biologists counted 40 trout in 10 minutes time. A great number of aquatic insects and other drift were observed. Stream was getting real milky and definate odor. Numerous short conversations were taking place as people came and left. I do not remember them very well, but general impression was people were concerned but didn't really know what to do. Several water and insect samples were collected.

1300 - Gene talked with Brett about notification of the public. Brett requested the USFS do it. Gene indicated his function was in monitoring.

1320 - Gene watched wrecker pulling out batch truck. A square tank and round medium tank were still left in the stream area.

1420 - Site 1 is 0.7 miles downstream from Site 3 so fish and insects were already dead when Gene and I got there.

1450 - Returned to Site 3 to change drift net and took water sample.

1524 - Drift net was taken out at Site 1 due to the short distance between Site 1 and 3 and we had more observations and data collection at Site 3.

1530 - Drove past area where diversion of water was being started. Cat working in or near stream. Did not see people directing cat operations. We thought the tractor was building a stream or channel dam to contain spill and flood water across flat areas.

1550 - Took aquatic drift sample at Site 2. Benthic Mayflies alive. We talked to Al Newman from the State Forestry at Harshman's Ranch and he indicated we were expected to be at helicopter site (Site 3) at around 1600 hours. We indicated we would be there as soon as possible. I made some quick calculations as Gene completed the data collection and drove to Site 3.

Assuming reservoir inflow at 20cfs:
Flow 20cfs for 1 day = 1.728×10^{6} cu.ft./day
= 2.939×10^{9} liters/day *

Carbaryl 900 gal. x 4 lbs AI/gal = 3600 lbs. AI or
1.633×10^{6} grams

Therefore the worst possible 24 hour mean concentration would be 555 ppb.* Normally peak concentrations are at least a factor of 10 times higher than this. I looked to me that unless something was done, probably most or all aquatic and fish life would be killed to the reservoir and aquatic insects would be killed to the Columbia River where concentrations would be diluted to below toxic levels to insects. No fish kill was predicted below the reservoir.

1605 - We were a few minutes late to the discussion meeting at Site 3 (helicopter landing area). There were representatives from USFS, OSDF, DEQ, Sherriff's Dept, Union Carbide, and helicopter contractors. The ones I can remember included Brett McKnight, Dan Shultz, Al Newman, Gene Silovsky, Ben Seminole, Jim Phelps, Ron Terwilliger. There was some discussion on who was in charge and who had authority to coordinate cleanup. There seemed to be a lack of knowledge on what to do to contain a spill of this nature.

I indicated that I was a hydrologist and had thought about what could be done in a worse case situation as this. Damming the stream or using a backhoe to dig hole(s) in the channel and irrigate the surrounding area with the stream in an attempt to dewater the stream of the concentrated spill waters seemed to be the best choice. I thought the Corps of engineers, area ranchers, or Ranger District fire crews may have pumps to handle something like this. Another alternative that I mentioned was to divert the water onto flat fields to slow water movement, encourage adsorption to organics. Some of these thoughts had been mentioned to others earlier, but I can't remember who or when. I talked earlier several times to Ron Terwilliger, Al Newman, Ben Seminole, Brett McKnight, Gene Silovsky about possible containment methods on an advisory basis. I indicated that I had no authority to tell the Contractor what to do but if something was not

*NOTE-These figures are wrong. Apparently in changing cu. ft./day to liters/day I multiplied by an extra 60. I used 450 gal/sec. rather than 450 gal/minute. The worse possible 24 hour mean concentration should be 33.4 mg/l (ppm). Apparently the solubility of carbaryl in water is between 30 and 50 ppm. Otherwise the concentrations would have been higher at the monitoring sites.

done to contain the spill, probably all aquatic fish life would be killed to the reservoir and aquatic insects killed below the reservoir to the Columbia River. I indicated that aquatic insects begin dying at 5 ppb carbaryl with some species more tolerant than others. Stoneflies are the most sensitive aquatic insects and Chinook Salmon and trout the most sensitive fish. I was unsure as to the effects from the diesel concentrations, but indicated it was at least a contributing factor to aquatic organism mortality. Several of those at the meeting had watched us check for live aquatic insects at one location or another. I tried to stress our primary purpose in monitoring the spill and we would be available if needed for consulting on cleanup.

Others didn't think much of the irrigation idea but thought diverting Willow Creek across flat pasture land may have some merit. That seemed to be the direction agreed upon as well as one or more additional charcoal dams.

It sounded like residents to Heppner had or were being notified to not use water and move cattle to higher ground. This sounded like good advice under the circumstances.

I indicated that activated charcoal is the standard spill clean-up material and I was unaware of the ability of charcoal briquets, but the low amount of surface area and rapid flow through briquets seemed ineffective. Contractor apparently heard from Union Carbide that charcoal briquets would be effective.

I think Brett McKnight was feeling that the stream was flowing slow enough that it would not reach the reservoir the next morning. I made a specific point of mentioning that the chemical slug had traveled at least 7 miles below the spill site in the last 12 hours. Someone said there as already dead fish at the North Fork which is even further downstream. I indicated that stream travel was then 1/2 to 3/4 miles per hour, but it is unknown if the stream travel rate will continue on the lower stream section. Flow velocity usually is much faster on downstream area with similar gradient but the lower sections of Willow Creek are lower gradient with meanders. I felt we should expect the same flow rates which would put the spill at the dam in 16 to 24 hours (or between 0800 and 1600 on 6/14/82.)

My impression was that structures as charcoal filter and water diversion and/or storage across meadows would be utilized to promote absorption of the chemical. It sounded like work would be accomplished by sundown with Brett to check work accomplishments.

Before we left, a morning meeting at 7 a.m. at Wagon Wheel Restaurant was set up. The State lent me a radio which later did not seem to work (batteries?). I also finally received a radio from Tupper. Apparently I was sent a radio earlier but did not receive it. Communications between people were really poor. People were driving from place to place looking for someone all day. The State Forestry seemed to have the best communications. (All Gene and I had was a Malheur National Forest radio which did not work on the Umatilla National Forest).

After the meeting, Ben Seminole asked me if someone from the Budworm Project was to coordinate USFS efforts. I told him that I could not understand why someone was not assigned to help with the communication, coordination, and notification efforts. State Forestry personnel also felt the USFS should be taking a more active role in the spill decisions.

Gene and I stopped by Site 2 to check for live insects briefly before going to Heppner to buy supplies and get something to eat from 1730 to 1815.

1855 - We established monitoring site at Site 4 located at Willow Creek bridge approximately 1 mile above reservoir. Installed aquatic drift net and took water sample.

1920 - Returned to Site 2. Stream was muddy from dam diversion up stream. Numerous (25-50) dead caddis floating by in one minute. One distressed lamprey near bank at 1945 hours. Drift net was clogging with sediment. Water sample taken at 1950.

2010 - Gene and I went upstream to the diversion site to check out why fish were still being killed. Diversion was only moving water across a short reach of pasture before it reconcentrated into a diversion ditch before dumping back into Willow Creek. The diversion was only partially usefull because water was moving too rapidly across pasture. Some diesel was depositing in calmer areas. In a 100 yard section below the dam, numerous dead rainbow trout, suckers, sculpin, and dace were found. A few individuals were still alive but obviously distessed. About 12 legal trout were counted in the 100 yard section. Water sample at 1950.

2015 - We traveled to Site 1 where we had a flat tire. A woodcutter helped us with the proper size lug tool. Water sample taken at 2030.

2145 - Arrived at Skinner Creek dam site. Distressed trout below dam. Caddis flies and Mayflies dead. Took a water sample at 2200. Scum on water surface above and below dam. Dam was constructed with charcoal briquets again which was upsetting to us. The water was moving too rapidly through the briquets to absorb very much. Oil boom on surface seemed to be collecting some diesel.

2230 - Site 2 took water sample at 2240 and changed drift net. Distressed suckers and dace present. Dead trout in drift net. Waters still muddy and difficult to see drift in this rapid section due to turbidity.

Called Randall Perkins and told him our beliefs that containment has not been effective sufficient to avoid fish kill all the way to the reservoir. Our concerns were that contamination will reach reservoir and that there has not been enough OARS (DEQ) personnel and expertise to adequately handle a spill of this magnitude. I expected aquatic insect mortality below the dam if it cannot be contained. I believed more direct measures should be taken to contain the spill. Contractor seemed cooperative but no one was willing to take charge and tell him what needs to be done. I-was also concerned over the use of charcoal briquets for absorbant. Landowners and towns people seemed to be aware of the spill and some were concerned. (We were grateful the Harshman's left their telephone outside for our use overnight).

2300 - Returned to Site 4. Live Mayflies numerous on stream rocks. Water clear and drift organisms alive. Water sample taken.

2315 - Slept at Site 4 for a few hours. We were pretty tired.

JUNE 14, 1983

0345 - Took aquatic drift sample at Site 4. Not much in net. Insects and bugs in net alive as were those on channel rocks. Water was not turbid.

0500 - Checked net again at Site 4 (Willow Creek bridge one mile above reservoir). Mayflies, etc. were still alive in net and on rocks. Water may have been slighly murky from upstream dam construction.

0520 - approx. Site 1 Oil slick on water and still smell chemical.

0548 - Returned to Site 2 where water sample was collected and drift net changed. Smelled the presence strongly in the water. The water was still muddy but not as much as last night. A few dead fish were seen, but the few pools in this section did not promote bank or eddy deposits.

0600 - Skinner Creek charcoal dam site had dead dace and sucker below and water was muddy. Oil sheen was on the water and the boom had accumulated some surface scum.

0620 - Returned to Willow Creek bridge (Site 4) and talked to Jim Phelps, (OFWL). Transferred 18 water samples to him so Bob Krein could take to Columbia Laboratory on his way to Portland. Aquatic drift was occurring at Site 4 so some chemical was reaching area.

0700 - Wagon Wheel restaurant. Ate breakfast and started meeting about 0730. Names of attendees were collected.

I mentioned the leading edge of the spill should be reaching the reservoir now. Caddis Flies were seen at the bridge site about one hour earlier. Fish were killed below the charcoal filter near Skinner's Creek. Efforts to contain spill have not yet been effective. Activated charcoal dams or irrigation of flat area adjacent to stream could still be done above reservoir to remove some of the chemcal, but need to start right away.

Experts from Union Carbide were not experienced as spill containment and cleanup experts. I think Brett was counting on their solving the problem, but realized that some real spill cleanup experts were needed.

We did talk about the breakdown of carbaryl in water. Area streams are generally alkaline with pH of about 8, but I had no measurements on Willow Creek or reservoir to confirm this.

Some aquatic insect kill downstream of reservoir is likely and may go to the Columbia River. Gene and I will monitor downstream effects as time permits and let them know results of water samples.

We talked briefly of cleanup tools and I mentioned a type of pump which may be useful in this. (I left meeting to provide information to Contractor). I also talked about putting activated charcoal in filter cloth (used in road engineering) or using bark chips or sawdust to provide for absorption of chemicals. I made it clear I had no authority to authorize expendatures or require work to be done.

1000 - approx. Returned to Wagon Wheel and was surprised to see the meeting still going. The Corps of Engineers building was closed earlier so we could not find out dam storage. Brett McKnight was on the phone more and more. Somewhere in the discussion I found out that the decision was made to call in a specialty team - Environmental Emergency Services Co. I thought that was what needed to be done on 6/13/83, but somewhere people were under the impression that Union Carbide personnel were to fill the role of spill containment and cleanup experts. I was concerned that OARS (DEQ) had only one person to handle direction to the spill. Things were happening in Willow Creek and everyone was still debating on what to do since the spill was reaching the reservoir. The reservoir was being considered to hold the spill as much as possible to provide dilution and promote decomposition of carbaryl.

1030 - Gene and I left meeting for Site 4 to find out what had happened since we left. Drift net changed at 1045 and water sample collected at 1105. Dead and dying fish were found.

1130 - approx. Gene and I left Site 4 to check upstream sites and road mileages to different sites. We stopped to look at Mallard ducks feeding in Willow Creek above Hardman's ranch about two miles. Gene indicated they appeared to be acting normal as they flew away.

1203 - Stopped at Site 1 and noticed strong chemical smell still persisting. Dead lamprey, crawfish, and trout were noticeable along bank pools. We could find no noticeable live benthic organisms. We continued to drive upstream taking mileages and noticing affects.

1215 - Water sample at Site 3.

1240 - Water sample from Cutsforth Pond outflow. Lots of foamy diesel along edges of pond and water was somewhat cloudy. Water flowing out of pond was still contributing chemical to Willow Creek. Heavy smell still present.

1300 - Water sample below spill site 100 yards. Smell of chemicals still very strong and diesel foam deposits on debris and along banks were very evident.

1330 - Water sample and removed drift net at Site 2. Chemical smell still present.

1400 - Returned to Site 4 and took water sample and drift net out. Chemical smell present.

1450 - The Sheriff stopped and told us that Brett McKnight wanted to talk to me a the Sheriff's office.

1458 - Met Bill Butler, USFS Budworm Project, as we were turning toward Heppner. He came from a discussion with Ben Seminole. Ben (and I) felt someone from the Budworm Project should have been more involved to help coordinate information transfer. Apparently under the full service contract, this is not required.

1505 - Brett McKnight had called a meeting to indicate the actions taken and would be taken to contain the spill and notify water users. Basically the Heppner Reservoir was to be closed at 1630 and residents are being notified below the reservoir to avoid water use if possible or at least check for live aquatic insects. Brett still was overpowered by the magnitude of the project, but was making decisions necessary to contain the spill in the reservoir. He still was on the telephone alot and could use a secretary and field assistant.

I met Bill Sobolowski and Ron Culver from the EPA who needed to know what kind of monitoring had been done. Brett asked if I would conduct them on a tour of the spill and monitoring areas. They also wanted to take some water samples at points below the spill and below the reservoir. I had some work to do on sample preparation to send them to the laboratory, so Gene took Ron and Bill to a monitoring site (Alfalfa Creek, bridge) below the reservoir (Site 5) at 1555. Gene installed a drift net and noticed live Mayflies and diptera larvae present.

1625 - Gene returned and I took Bill Sobolowski and Ron Culver on a tour of the monitoring sites that were established and showed them the spill area. Gene went to check on insects again below the reservoir.

1639 - Water sample taken by Ron Culver (EPA) at Site 4. Apparently the sample bottles came from DEQ. I remarked about the sampling methods which should be used to avoid cross contamination between samples. I was especially distressed that the foil liner for the sample lid was folded inside the bottle. This may be OK for spills with high concentrations, but it definately increases the potential for contamination at low concentrations. The sampler must retrieve the foil inside, and somehow unfold and place the foil over the sample without contaminating it. I suggested that a better quality foil be used so the original foil need not be replaced.

1703 - I took a water sample at Site 2 for the EPA representatives because I had hip waders on. Gene was at Site 5 where live fish, dipters, and mayflies were present. No dead drift in net.

1710 - Gene recorded live caddis and mayflies at Site 6 approximately 1 mile below Heppner dam. Ben Seminole and Robin Metz, U.S.F.S. Heppner Ranger District collected data below reservoir during the evening.

1720 - Another water sample was taken for EPA analysis at Site 3. We then went upstream to look at Cutsforth Pond and spill site.

Gene and I went back to Heppner and ate before returning to John Day. The reservoir was to be closed for several days to store, dilute, and provide time for chemical breakdown.

Results from calculations indicated the reservoir would dilute incoming water by at least a factor of 10. Reservoir inflow included 13.3 cfs (27 acre-feet per day) from Willow Creek and about 6.7 cfs (13 acre feet) from other sources. The reservoir had about 320 acre feet when closed off.
Ben Seminole and Robin Metz helped us collect data below the reservoir that evening.

JUNE 15, 1983

Gene Silovsky returned on 6-15-83 to keep abreast of the situation.

1115 - A water sample was taken at Site 4. The Oregon Dept. of Fish and Wildlife were installing a live box with trout.

1320 - Fish at Site 4 were almost dead. They were still breathing but belly up. A live fish box was put in below dam with two trout. About six (6) inch trout, active and well, were seen downstream from box.

1650 - Live caddis, stone and numerous Mayfly larvae were found in Willow Creek at the Bunker Hill Road crossing about 4-5 miles downstream from the reservoir. Many live dace and suckers were also ovserved.

1920 - Site 6 about 1 mile downstream from reservoir. Live caddis, Mayfly, and diptera larvae. Live fish also found with no evidence of insecticide affects.

2000 - Took water sample and changed drift net at Site 5 (Alfalfa Bridge). Live diptera larvae were found.

JUNE 16, 1983

I was busy investigating a helicopter forced landing at Miller Prairie most of the morning and early afternoon.

1530 - Called Columbia Laboratories to obtain results of water analysis tests. Results of all water tests are presented in Table 1.

1800 - Presented water data to Brett McKnight.

2125 - Live caddis, mayfly and diptera larvae at Site 6. Drift net was gone (taken by children and later returned by Jim Phelps, OFWL). Numbers of insects seemed lower than were found earlier. Could be due to lower water conditions, pesticide, or impact of the number of people looking there.

2140 - Site 5 seemed to also have fewer numbers of insects (this site was lower in productivity from the start). I suspected some chemical may be getting through the reservoir. Water sample taken.

2220 - Two dead trout in live box at Site 4. Water sample taken. Ben Seminole and family were also present at Sites 4 and 5.

JUNE 17, 1983

0800 - Early morning briefing on reservoir. One half of the fish below the reservoir were dead in transplanted live box. I mentioned that last night I found some reduced numbers of insects, but I did not see how the concentrations would be high enough to kill fish. Transplanted fish normally have some mortality and this was not being brought out to the media. I talked with Jim Phelps and Brett McKnight about qualifying information released to news media. Shocking and transporting fish normally causes some mortality. Some of the fish may have come from the Portland area. I did not see how the concentrations could be high enough to directly kill fish.

P.M. - Met with DEQ biologists Jerry Bell and Krystyna Wolniakowski briefly to discuss their findings. They found Stoneflies dead below the reservoir several miles. Mayflies - some dead and some alive at Alfalfa Cr. Bridge (Site 5).

1400 - Removed Alfalfa Bridge (Site 5) drift net. Updated Brett on results of water analysis information. See Table 1 and figure 1.

JUNE 18, 1983

0930 - Met with Brett McKnight and others on reservoir situation. Ernie Felix, hydrologist Umatila N.F., was going to do a dye tracing study of water flowing into the reservoir. I calculated that 10 liters of 42% Rhodamine would turn the whole reservoir red. He indicated that he planned to use 100 ml. which sounded like the proper amount to use. Several went to watch and map dye dispersal. Gene and I left to Check on the Miller Prairie spill.

PM Ernie had mapped out movement of dye in Heppner Reservoir. Apparently the dye stayed mostly at the inlet end and eventually dissappeared. Rapid mixing thoughout the reservoir was not evident. This is what I expected.

Talked with DEQ biologists some more about follow-up monitoring. No definate plans had been made. They had not seen a stream system so totally dead before and thought this provided an excellent opportunity for study.

JUNE 19, 1983

Briefly talked to Brett about meeting on 6-20-83 to decide what to do. I indicated that Gene and I would be there.

JUNE 20, 1983

0800 - Met with Brett McKnight before decision on how much to open reservoir. Brett apparently wanted to get rid of the water quickly by releasing it at 100 cfs. Gene and I talked to Brett about releasing water more slowly to encourage futher breakdown of the pesticide and dilution due to inflowing water. Brett indicated the half life for carbaryl was about 5 days at pH 7.6. Brett seemed receptive to the idea of letting water out at a slower rate. I stressed again that downstream fish kills were doubtful in my opinion.

Brett received the results of water samples collected within the reservoir. Values ranged for 0.1 ppm to 0.3 carbaryl plus 1-naphanol. These concentrations were well below levels found toxic to fish.

1000 - Heppner reservoir had 475 acre-feet of water which substantially diluted incoming chemical concentrations.

1100 - Jim Phelps, Jerry Bell, Krystyna Wolniakowski, Gene Silovsky, Brett McKnight and I went to Site 5 to prepare to assess the affects of the release from the reservoir. We dismantled the charcoal filter (or what was left of it) and the sandbag and grass clod dam which was to force water through the filter. The dam was not sufficient to back up water and

almost all the charcoal was washed out from the filter (about a 3 foot concrete pipe section which was filled with charcoal).

We went downstream and shocked up about a dozen live trout in the 6-12" size class. These were placed in the live box at the Alfalfa Bridge (Site 5).

1200 - Corps of Engineers started letting more water out of the reservoir at the rate of 30-35 cfs. There were no noticeable immediate affects to aquatic insects and the fish in the live box were all right. Gene and I left and the others were going to monitor the situation.

Gene and I have since made several calls to other inquiring about the status of aquatics downstream. The DEQ biologists were going to develop a long-term stream study plan for our review. Concentrations flowing into the reservoir were still 0.13 ppm on 6-23-83 according to Steve Gardels (DEQ).

This report is the chronology of events as I remember them. I have also enclosed some comments on areas which could be improved in spill management

Bill Hansen

BILL HANSEN
Hydrologist - U.S. Forest Service
Environmental Monitoring Coordinator - Spruce Budworm Project

TABLE 1

WILLOW CREEK WATER SAMPLES

Site	Description	Date	Time	Results (ppm)*
1	6.9 miles below spill	6-13	1015	--
			1130	--
			1430	--
			1523	--
			2030	39.9
2	Harshman's Ranch 13.7 mi. below spill	6-13	1950	4.4
			2240	12.5
		6-14	0545	16.5
			1335	5.0
			1703(EPA)	4.6
3	Helispot 5.8 mi. below spill	6-13	1200	--
			1248	13.8
			1325	26.3
			1400	28.3
			1500	32.3
		6-14	0528	14.5
			1215	8.7
			1720(EPA)	2.6
4	Willow Cr. Bridge above reservoir 20.9 mi. below spill	6-13	2310	--
		6-14	0635	2.6
			1105	8.7
			1405	7.6
			1639(EPA)	5.0
		6-15	1115	3.1
		6-16	2210	1.5
		6-18	1520	--
5	Alfalfa Street Bridge just below Heppner Reservoir	6-14	1545(EPA)	0.11
			2100	--
		6-15	0200	--
			1030	--
			2000	0.0
		6-16	2140	.0005
6	Bridge about 1 mile below reservoir	6-15	1030	--
7	Bunker Hill Rd. 4-5 mi. below reservoir	6-18	1448	--

MISCELLANEOUS SAMPLES

Site Description	Date	Time	Results
Below charcoal dam near Skinner Cr.	6-13	2200	--
100 ft. below Site 3 and below charcoal dam.	6-13	1325	--
100 yds. below spill site	6-14	1300	--
Outflow from Cutsforth Pond	6-14	1240	--

* -- indicates sample was not analyzed.
0 = none detected (less than 1 ppb).
Samples have been field extracted and could be analyzed if data is necessary.

EPI MI 10 X 10 TO 1 INCH
10TH LINE HEAVY

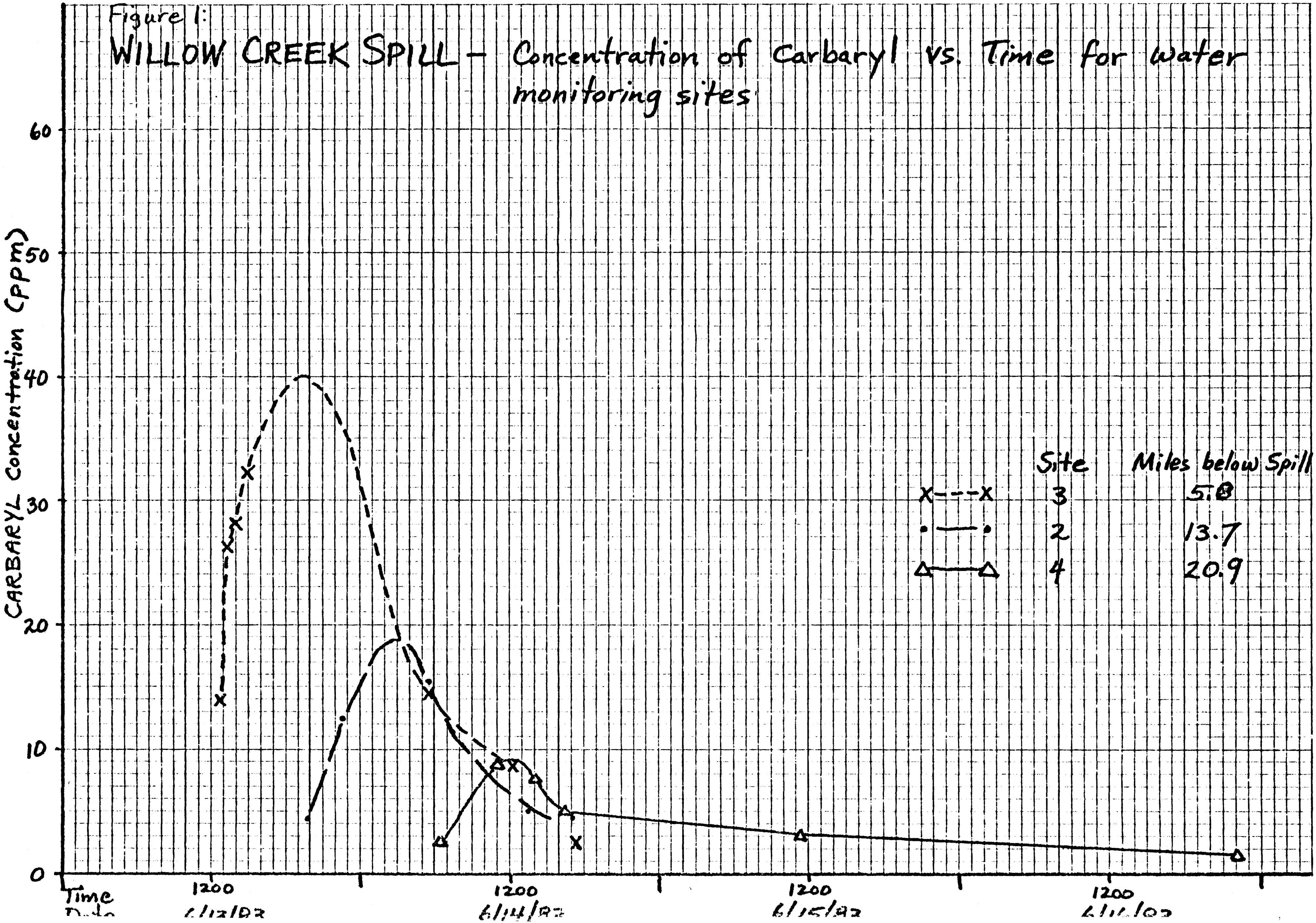


Figure 1:
WILLOW CREEK SPILL - Concentration of Carbaryl vs. Time for water monitoring sites

WILLOW CREEK SPILL

Estimated Carbaryl Reaching Heppner Reservoir
(from site 4 data Willow Cr. = 13.3 cfs)

Day *	Mean Concentration (ppm)	Carbaryl (lbs)
1	4.8	344
2	2.5	179
3	1.5	108
4	1.0	72
5	0.8	57
6	0.6	43
7	0.5	36
8.	0.4	29
9	0.3	22
10	0.2	14
Ten Day Total		904

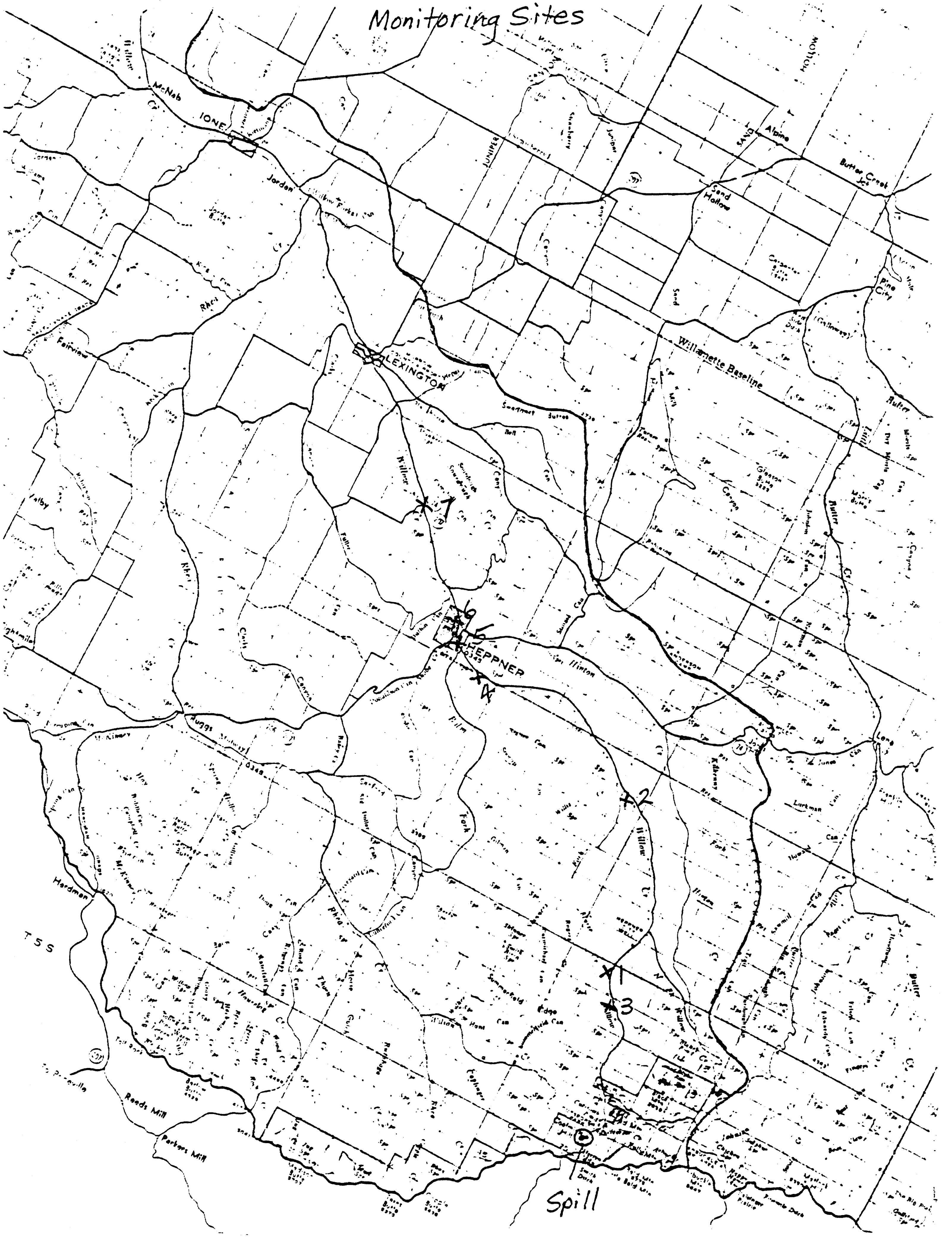
*Day one is 6/14/83 0600 to 6/15/83 0600.

AQUATIC DRIFT

Samples

STREAM	SITE	TIME START		TIME END		REMARKS
Willow Creek	1	6/13	1015	6/13	1420	1 of 2
Willow Creek	1	6/13	1015	6/13	1420	2 of 2
Willow Creek	2	6/13	1100	6/13	1550	
Willow Creek	2	6/13	1550	6/13	1920	
Willow Creek	2	6/13	1920	6/13	2230	1 of 2
Willow Creek	2	6/13	1920	6/13	2230	2 of 2
Willow Creek	2	6/13	2230	6/14	0545	
Willow Creek	2	6/14	0545	6/14	1330	
Willow Creek	3	6/13	1200	6/13	1248	
Willow Creek	3	6/13	1248	6/13	1347	1 of 2
Willow Creek	3	6/13	1248	6/13	1347	2 of 2
Willow Creek	3	6/13	1347	6/13	1453	
Willow Creek	3	6/13	1453	6/14	1255	
Willow Creek	4	6/13	1855	6/13	2300	
Willow Creek	4	6/14	2300	6/14	0345	
Willow Creek	4	6/14	0345	6/14	1045	
Willow Creek	4	6/14	1045	6/14	1400	
Willow Creek	5	6/14	1555	6/14	2100	
Willow Creed	5	6/14	2100	6/15	0200	
Willow Creek	5	6/15	0200	6/15	0710	
Willow Creek	5	6/15	0710	6/15	1006	

Monitoring Sites



Comments on areas which could be improved in
Spill Mgmt.

1. Vehicles should be properly equipped with adequate emergency brades to stop a vehicle under full load when transporting hazardous or toxic materials.

2. Drivers hauling toxic materials should meet driving record and experience standards.

3. Use a pilot car before trucks hauling hazardous materials.

4. Difficult road turnoffs should be properly signed when hauling hazardous materials from site to site.

5. An adequate spill plan for all contractos applying or transporting hazardous materials should be required.

6. Provide a list of consultants to the contractor which could provide technical advice on particular spills.

7. Document what responsibilities and authority individuals would have in case of a spill. This is especially true of contractor, landowner, OARS representative(s), Sheriff's Dept, other state agencies.

8. Communications were a problem on the Willow Cr. spill. Portable radios should be available to ensure all are informed of what is going on.

9. Provide some minimum list of equipment and materials which should be on hand for toxic material spills.

10. Field check operators for proper equipment used in transporting, applying, or cleaning up toxic materials.

11. On a large spill as Willow Creek, several OARS personnel should respond. A spill of this nature could use the following; An office person to collect and analyze available information, make decisions, delegate authority, and provide news releases. Field person to coordinate; direct, and inspect containment and cleanup operations and feed information to office persons. Office assistant to field telephone calls and answer questions from individuals and news media.

WILLOW CREEK SPILL

Estimated Carbaryl Reaching Heppner Reservoir
(from site 4 data Willow Cr. = 13.3 cfs)

Day *	Mean Concentration (ppm)	Carbaryl (lbs)
1	4.8	344
2	2.5	179
3	1.5	108
4	1.0	72
5	0.8	57
6	0.6	43
7	0.5	36
8	0.4	29
9	0.3	22
10	0.2	14
Ten Day Total		904

*Day one is 6/14/83 0600 to 6/15/83 0600.

Comments on areas which could be improved in
Spill Mgmt.

1. Vehicles should be properly equipped with adequate emergency brades to stop a vehicle under full load when transporting hazardous or toxic materials.

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APPENDIX I

AQUATIC INSECT COLLECTIONS ON WILLOW CREEK AND SOME TRIBUTARIES.

On September 30, 1983, at the request of the U.S. Forest Service, TAXON Aquatic Monitoring Service was asked to collect aquatic insects on Willow Creek -- located in the Umatilla drainage in northeastern Oregon. The upper end of Willow Creek was the site of a 1900 gallon spill of the insecticide Sevin 4-oil on June 13, 1983. Insects were collected by placing a 13.5 inch cylinderical enclosure, 1 square foot area, over gravel and rocks in the stream. Rocks within the enclosure were carefully scrubbed by hand to dislodge insects which were collected in a net attached to the cylinder. An attempt was made to sample a 3 inch depth of the substrate covered by 3 to 12 inches of flowing water. Areas with cobble size rocks were selected. Three, one square foot samples were collected and composited. Collected organisms were placed into a jar containing formaldehyde and stored for later laboratory analysis.

Analysis of the insects was done by hand picking animals from the debris - needles, leaves, twigs, sand, rocks and algae - collected with the insects. The samples were of large volume - 0.5 liter to 2 liter - and picking of all the organisms within the sample would have used excessive time. Therefore, a subsampling procedure was employed to reduce picking time. Samples were placed into a container and brought to a volume of 4 liters with water. While stirring the contents a 400 ml aliquot of the mixture of debris and insects was removed. Insects from this subsample were picked from the debris under magnification. The picked subsample size ranged from 6.25% to 25% of the composited sample.

In this report reference to a 'sample' refers to a composite of 3 benthic samples.

Sampling locations on Willow Creek were mostly low gradient, open to sunlight, warm, and contained large amounts of thick algal growths on a rocky substrate. These conditions may favor large populations of chironomid larva.

Sixteen composited samples were collected starting at a point 15 miles below Heppner, where Rhea Creek joins Willow Creek, to the headwaters of Willow Creek, 21 miles above Heppner - a distance of approximately 36 miles. Ten samples were collected throughout this distance on Willow Creek and one each on six tributaries.

Samples 14 and 15 - Table 5: - were collected on Willow Creek, one-quarter of a mile above and below the confluence with Rhea Creek. This location is the farthest from the spill. If the insecticide had leaked through the dam located above Heppner and destroyed the insect fauna here, it is possible that drifting insects from Rhea Creek helped to repopulate the area of Willow Creek below its confluence. Insect numbers on Willow Creek, below Rhea Creek - sample 15 - are considerably higher than the numbers collected at the station above. Insect numbers on Rhea Creek, about a half mile upstream of Willow, are larger than samples 14

or 15. By separating the diperians - that can have multiple generations each year, ie. Chironomidae - from the totals in Table 5: the differences are much larger, compare columns TOTAL and SBTOT. Sample 16 was collected on Rhea Creek, about 0.3 mile above Willow Creek. Insect numbers were very high in this sample, especially for net spinning Trichoptera and Diptera larva.

Insect numbers in Balm and Hinton Creeks should not be compared with those in Willow Creek, sample 13, because of habitat differences - lower flow volume and substrate differences. The large numbers of insects in sample 13 is remarkable, especially if leakage of the pesticide beyond the Willow Creek reservoir occurred and destroyed the aquatic insect community. The large numbers of Trichoptera larva in this sample should also be noted. These were large larva and may have been present before the June 13 spill.

Comparisons of populations in Willow Creek, sample 10, with Skinners Fork Creek are valid because of the similarity of habitat where the samples were collected. The Table 5: SBTOT - Ephemoptera, Plecoptera and Trichoptera - are nearly five times lower in sample 10. Plecoptera were nonexistent at the time of sampling. If destruction of the insects was complete after the spill, repopulation has probably occurred due to drift from tributaries and post spill egg laying.

The same imbalance of Diptera to other aquatic larva is observed in Willow Creek samples 3 and 4. A comparison between Willow Creek, sample 3, and Herren Creek can be made only in the fact that both were collected within a heavily canopied area. Herren Creek was very low flow and sandstone substrate opposed to the higher flow and rocky substrate where sample 3 was collected. No Plecoptera or Trichoptera were present in sample 3; the Ephemoptera and Diptera larva probably developed since the spill. Willow Creek, sample 1, was not below the spill. Its low numbers are a result of the trickle flow, steep gradient, sandy substrate and high erodability of the stream at the sampling location. It is notable that there is not the imbalance of the aquatic groups in this sample or any of the tributaries not affected by the spill. This was in contrast to the Willow Creek samples 4, 5, 7, 8 and 10 -locations that were probably most affected by the the insecticide.

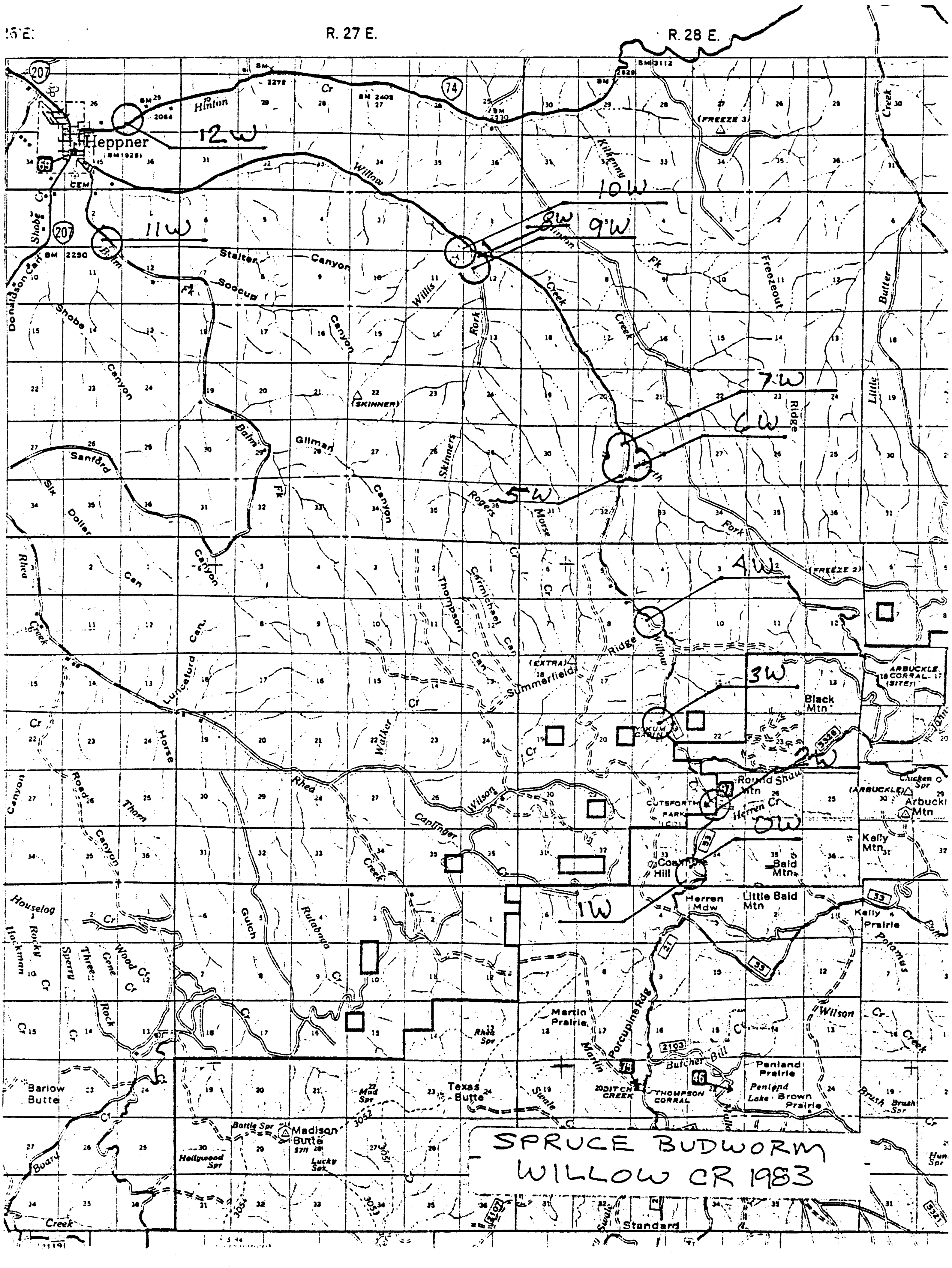
It is difficult to determine the health of the stream without some measure of species richness. Post-spill recovery of the aquatic insect community from the insecticide spill on Willow Creek in terms of insect numbers alone can be very misleading. A measure of the species richness, a diversity index, of Willow Creek compared with its tributaries of like habitat conditions would be a good indicator of the degree of recovery.

TABLE 5: POST-SPILL AQUATIC INSECT COLLECTIONS ON WILLOW CREEK AND ITS SELECTED TRIBUTARIES. NUMBERS ARE FROM COMPOSITS OF 3, 1 SQUARE FOOT BENTHIC SAMPLES COLLECTED ON SEPTEMBER 30, 1983.

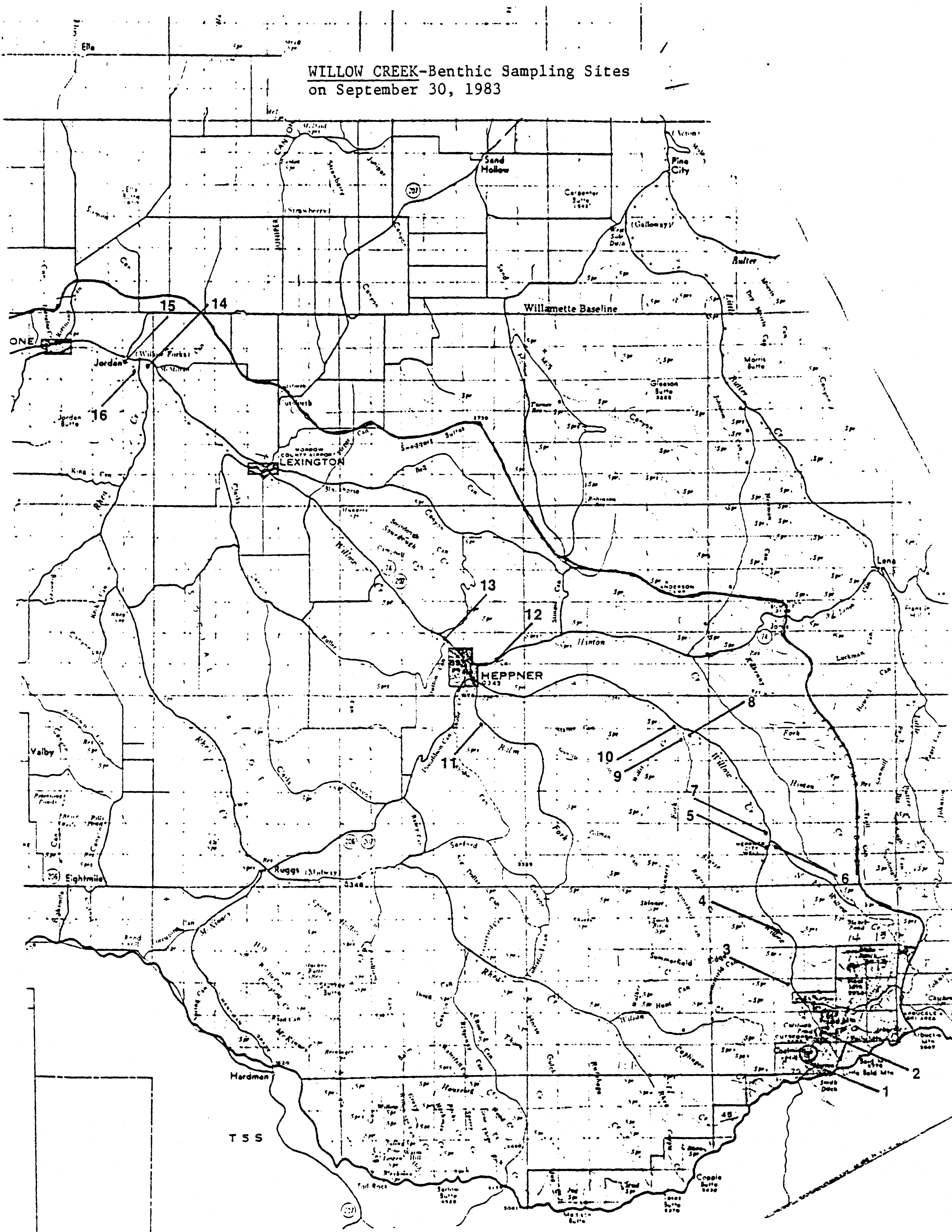
COLLECTION SITE	NO	EPHE	PLEC	TRIC	COLE	DIPT	SBTOT	TOTAL
WILLOW CR	1	164	48	4	4	200	216	420
HERREN CR	2	1048	504	184	48	472	1736	2256
WILLOW CR	3	64			8	464	64	536
WILLOW CR	4	448	128		16	2560	576	3152
WILLOW CR	5	176	112	128	16	2224	416	2656
NORTH FORK CR	6	720	656	64	256	448	1440	2144
WILLOW CR	7	304	120	160	48	748	584	1380
WILLOW CR	8	520	120	336	152	4504	976	5632
SKINNERS FORK	9	688	400	1424	384	432	2512	3328
WILLOW CR	10	400		128	128	2304	528	2960
BALM CR	11	368	48	1536	48	304	1952	2304
HINTON CR	12	528	16	512	48	432	1056	1536
WILLOW CR	13	1912	16	1648	96	376	3576	4048
WILLOW CR	14	92	4	748	48	504	844	1496
WILLOW CR	15	240	64	2416	32	2352	2720	5104
RHEA CR	16	248	8	4336	200	1104	4592	5696

EXPLAINATION OF HEADINGS:

EPHE	Ephemoptera
PLEC	Plecoptera
TRIC	Trichoptera
COLE	Coleoptera
DIPT	Diptera
TOTAL	Total of EPHE, PLEC, TRIC, COLE, and DIPT.
SBTOT	Total of EPHE, PLEC, and TRIC.


R. 27 E.
R. 28 E.
Heppner
12W
11W
10W
9W
8W
7W
6W
5W
4W
3W
2W
1W
0W
Hinton
Willow
Kilkenny
Stalter
Canyon
Soocup
Willis
Rock
Creek
Freezeout
Butler
Little
Ridge
Shobe
Donaldson Can
Balm
Fk
Skinner
Gilman
Skinners
Sanford
Six
Dollar
Rogers
Morse
Fork
Thompson
Carmichael
Summerfield
Luncefield
Horse
Walker
Rhea
Wilson
Canlinger
Round Shaw Mtn
Cutsforth Park
Herren Cr
Coalmine Hill
Black Mtn
Arbuckle Corral (Site)
Arbuckle Mtn
Kelly Mtn
Bald Mtn
Herren Mdw
Little Bald Mtn
Kelly Prairie
Potamus
Houselog
Rocky
Hackman
Sperry
Three
Gene
Wood Cr
Rock
Gulch
Rutabaga
Martin Prairie
Martin
Porcupine Rdg
Butcher Bill
Penland Prairie
Penland Lake
Brown Prairie
Thompson Corral
Ditch Creek
Texas Butte
Barlow Butte
Board
Madison Butte
Bottle Spr
Hollywood Spr
Lucky Spr
Mud Spr
Rhea Spr
Brush
Standard
SPRUCE BUDWORM
WILLOW CR 1983

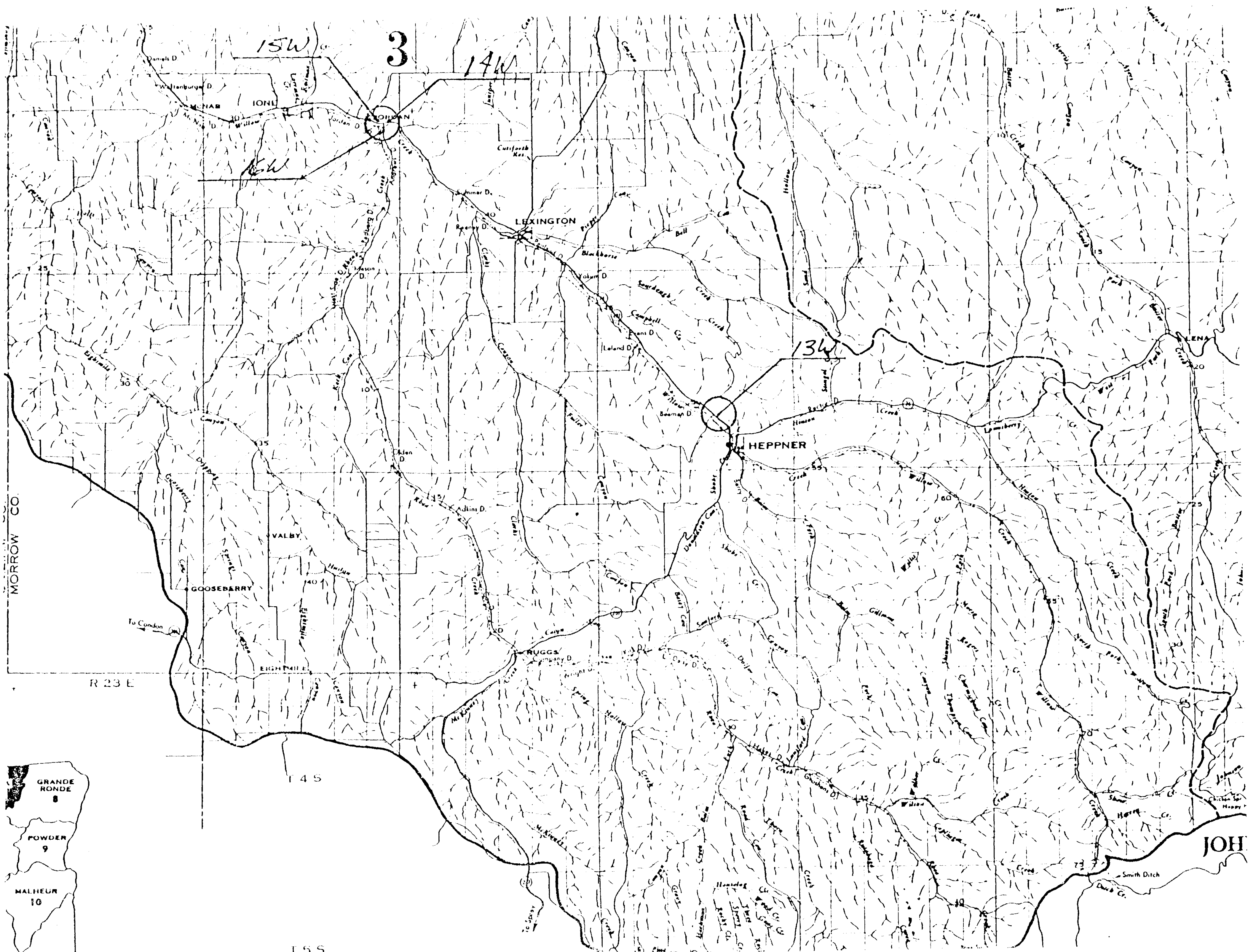
WILLOW CREEK-Benthic Sampling Sites
on September 30, 1983



Willow Creek Aquatic Insect Recovery Survey
Frequency Information by Sample Site (09-30-83) 1/

AQUATIC INSECT Order	Family	1. Willow Cr. above spill	2. Herren Cr.	3. Willow Cr. nr Yocum Cabin	4. Willow Cr. 5.8 mi. below spill	5. Willow Cr. above N. Fork	6. N. Fork Willow Creek	7. Willow Cr. below N. Fork	8. Willow Cr. above Skinners Fork	9. Skinners Fork	10. Willow Cr. below Skinners Fork	11. Balm Creek	12. Hinton Creek	13. Willow Cr. 1.5 mi. N. of Heppner	14. Willow Cr. above Rhea Cr.	15. Willow Cr. below Rhea Cr.	16. Rhea Creek
EPHEMOPTERA	Baetidae	144	64	64	256	80	368	244	472	272	320	320	448	1488	64	240	232
	Heptageniidae	4	192				304	36		16							
	Ephemerellidae	8	400		192	96		16	48		80	48	48	88			
	Leptophlibiidae	8	392				48	8		400			32	336			
	Tricorythidae														28		16
PLECOPTERA	Pteronarcidae									32							
	Nemouridae	36	184				160			256			16	16	4	64	8
	Capniidae	8	288				48					16					
	Perlidae						16										
	Perlodidae	4	32		128	112	272	120	120	112		32					
	Chloroperlidae						160										
TRICHOPTERA	Hydropsychidae		16			128	64	148	328	1372	128	1520	512	1648	748	2416	4320
	Glossosomatidae		144							32							
	Hydroptilidae								8			16					
	Brachycentridae		8														16
	Lepidostomatidae		8														
	Limnephilidae	4	8					12		16							
COLEOPTERA	Elmidae	4	48	8	16	16	256	48	152	384	128	48	48	96	48	32	208
DIPTERA	Heleidae																16
	Tipulidae	12	96		64	16	48	40	80	80	32		16				
	Chironomidae	188	368	296	1328	816	384	128	3288	336	2112	208	400	336	604	2336	840
	Simulidae		8	168	1152	1392	16	572	1128		160	96	16	40			40
	Stratiomyidae									16							
	Empididae				16			8	8							16	
TOTAL		420	2256	536	3152	2656	2144	1380	5632	3328	2960	2304	1536	4048	1496	5104	5696

1/ Review enclosed maps for sampling site locations. Sampling area was 3-1 square foot benthic samples. Subsample size was 1/4, 1/8, or 1/16 depending on insect numbers. The Willow Creek spill occurred on June 13, 1983. Collected by Taxon.


3
15W
14W
13W
16W
IONE
MCNAB
Willow
LEXINGTON
HEPPNER
LENA
VALBY
GOOSEBARRY
RUGGS
EIGHTMILE
MORROW CO.
To Condon
R 23 E
T 4 S
T 5 S
GRANDE RONDE
8
POWDER
9
MALHEUR
10
OWYHEE
JOH
Smith Ditch
Cutsforth Res.
Blackhorse
Sourdough
Campbell
Leland D.
Hinton
Gooseberry
Eightmile
Rhea
Adkins D.
Willow
Creek
Canyon
Hollow
Butter
Sand
Shobe
Balm
Rock
Spring
Hollow
McKinney
Hahn
Juniper
Tribble
Ditch
Duck Cr.

APPENDIX K

Miller Prairie Spill

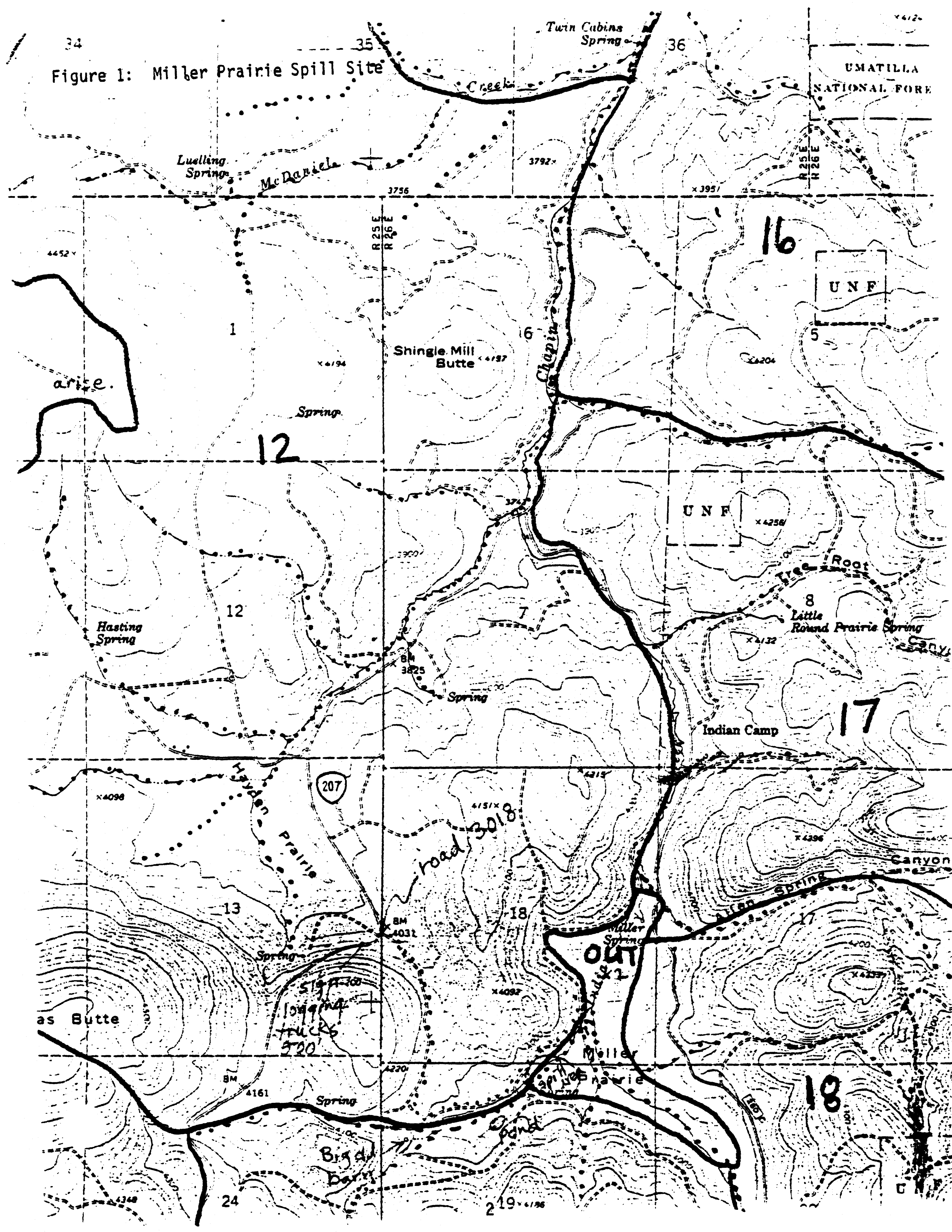
(T. 6 S., R. 26 E., Section 19, NW¼NE½)

The Miller prairie spill occurred on 6/16/83 (early a.m.) when a helicopter had to land fast when its insecticide tank shifted and the connections broke, allowing pesticide to flow into the cockpit of the helicopter. The pilot adjusted by keeping the nose up to avoid the chemical as much as possible and started spraying to get rid of as much as possible. Just prior to landing, a marshy area was sprayed and leaked into. Upon landing, the rest of the chemical quickly drained onto the soil. Workers were on the site and quickly contained the pesticide from directly flowing into the marshy area.

I was notified early in the morning about the spill and that no water was near the spill site. Since I was going to Heppner, Oregon, and the Willow Creek spill area anyway, I felt I should look over the spill site. I had difficulty finding the spill site and the observer helicopter had to help me find it. Rae Ann Jones and Mark Westenhaver of the Budworm Work Center at Tupper also helped with the use of their radio.

At 1300 hours I reached the spill site and found that a marsh had been sprayed (Figure 1). The water in the marsh was very slow moving and the presence of the diesel could easily be seen on the water and clinging to the vegetation.

Figure 1: Miller Prairie Spill Site



Monitoring Site 1 was about 1/4 mile below the spill and overspray area about 200 yards below where the water from the marshy area had channelized and a gully was cut into the soil. The stream is Indian Creek (a tributary of Chapin Creek which flows into Rhea Creek.) A water sample was taken at 1350 hours and contained 74 ppb carbaryl. Live caddisflies, mayflies, and small fish fry were found. An aquatic insect drift net was set. There were not many typical sites due to the slow water conditions.

I moved upstream about 200 yards to where the water began to cause gully erosion. Live mayflies, diptera, and fish were seen at 1405. A water sample (also 74 ppb carbaryl) was taken at 1402 and was a composite of three small streams which fell into the gully. At 1415 hours I observed a few dying insects (mayflies) drifting downstream.

I called Tupper Work Center and asked them to relay information to headquarters concerning the spill, that water was involved, a few insects were observed to be dying, and some additional work was needed by the contractor to minimize downstream impacts. I was called back and told to make contact with the contractor and have him take care of the situation.

I spent the next few hours finding the contractor and indicating to him what I felt needed to be done. Although the contractor was cooperative, he did not have on hand supplies needed to clean up or absorb spills.

At 1830 hours I took another water sample for analysis at Indian Creek, Site 1, and it contained 46 ppb carbaryl. There were just a few live insects in the drift net but the stream did not appear very productive (mostly soil benthic material). Caddisflies, where found, appeared to

be withdrawing into their case as if they were going to pupate. The carbaryl appeared to be stressing the caddis flies but they were alive inside their cases. Small live fish were also seen.

On June 17, 1983, Monitoring Site 2 was visited at 1040 hours. Mayflies, diptera, and a few caddisflies were mostly alive in drift net. Many of the caddis seemed ready to emerge and a few looked dead. Plenty of live small fish were still present. There was no detectable sheen on the water but some foamy bubbles were present which suggested traces of diesel (and carbaryl) may have been found.

Observations at Site 1 also indicated signs of surface scum from diesel and some live caddis and mayflies were found on the rocks or bottom. The water was flowing about 0.1 cfs and velocities were generally very low with large pools downstream. Frank Joseph, application contractor, came out to the site to put in another check dam with charcoal briquets. I recommended that he should place it downstream from the spill at least another 1/2 mile to get ahead of much of the chemical. He did what he could with a couple bags of charcoal and a shovel.

The aquatic drift net was removed from Indian Creek at 1730 hours. Live mayflies, diptera larvae, and small fish were present. Observations suggested impacts were not severe enough to warrant returning each day to make additional data collections.

On June 20, 1983, Monitoring Site 2 was visited from 1400-1430 hours with Gene Silovsky. A water sample was collected and later analyzed to contain 20 ppb carbaryl. Live aquatics found included mayflies, caddisflies, diptera larvae, and small fish. Caddisflies were alive but still inactive in their cases.

Gene Silovsky visited the spill site on July 18, 1983, at 0930 hours (enclosure). He found mayflies common and numerous caddis had emerged. Numerous live fish (assumed to be dace) were also present.

Later on the afternoon of July 18, 1983, Gene took Steve Gardels, Director of the Pendleton Office of the DEQ to the spill site. Steve dug into the soil and carbaryl was present at least four inches down into the soil. He indicated the high ion biding capacity of the organic soil would prevent movement of pesticide into the marsh when the wet season starts and nothing else was needed to reclaim the site.

Gene suggested that several bags of lime be poured over the main spill area to promote breakdown of the carbaryl. That seemed to be a good idea to me and Gene documented this in the letter to the Project Director. I do not know if this was accomplished.

BILL HANSEN

Hydrologist

Enclosure

1983 Western Spruce Budworm Suppression Project
USDA, Forest Service
Oregon Department of Forestry
John Day, OR 97845

2540 Water Uses and Development July 20, 1983

Miller Prairie - Spill

Randy Perkins, Project Director

On July 18, 1983, I visited the Miller Prairie helicopter spill site at 0920 and checked the creek system for 20 minutes. Mayfly larvae were common in the creek and numerous caddis fly cases examined indicated the pupae had successfully emerged. Numerous live fish (assumed to be dace) in the one inch size class were also present.

On the afternoon of the same day the Director of the Pendleton Office D.E.Q. and I visited the spill site. Steve dug into the soil and we saw Sevin present at least four inches down in the soil. Steve indicated the high ion/binding capacity of the organic soil would prevent the Sevin from moving into the marsh when the wet season starts. He also indicated nothing else need be done to the site.

I would feel more comfortable if we spread about five bags of lime over the spill (area of dead vegetation) to buy some insurance. I recommend we do this in the next 10 days before we get any significant precipitation.

GENE SILOVSKY
Assistant Environmental Monitor

cc: Bill Hansen
Gene Silovsky

APPENDIX L

Antelope Mt. Spill

T. 17 S., R. 35 E., Section 32

(Logan South 2 Entomological Unit)

On July 6, 1983, between 7:00 and 8:00 a fully loaded helicopter crashed on Antelope Mountain about 500 yards from a heliport. Nearly all of the Sevin-4-Oil (400 gallons) spilled on the ground as did much of the helicopter fuel. About 40 gallons of Sevin-4-Oil remained in the insecticide tank which was thrown clear of the helicopter.

The contractor's crews placed five bags of lime on the spill. Some lime was also placed in the insecticide tank on the following day. There was no standing or running water within one-quater mile downhill of the crash site. All of the chemical eventually ended up on the ground at the crash site. There was little probability that it would move from the site in the short term; i.e. one - two weeks.

The contaminated soil was to be dug up and removed to the Arlington disposal site by the contractor. Most of the spilled chemical was within a 10 yard radius of the helicopter.

I do not know if the contaminated soil was removed to Arlington as I last visited the site on July 9, 1983.

GENE SILOVSKY

Wildlife Biologist

Appendix M

Cow Creek Spill

July 18, 1983

Randall Perkins, Project Director

Cow Creek Spill - Helicopter Crash

Monitoring Notes
July 13, 1983

Bill Selby called me about the spill at 0645 hours. The spill was located north of the Lowe Mill Site in the Cow Creek drainage (T 20 S, R 32 E, Section 26, SW 1/4 NE 1/4.) A loaded helicopter with 110 gallons of Sevin 4-Oil mixture crashed when the pilot was blinded by the morning sunlight. About 20-40 gallons (40-80 lb. active ingredient) spilled into upper Cow Creek.

I called Mike Cavin back in a few minutes and asked him to suggest to Bill Selby that a pump could be used to dewater the stream, irrigating the affected waters on dry forest soil. Mike indicated he would be in contact with Bill Selby to see what could be done. I talked with Bill Selby before leaving the office at 0730 and he indicated the contractor and the Burns District were using pumps in attempts to remove the contaminated water.

I arrived at the spill site at 0930. Linda Mullens and Allison Hassler were also with me. At the time of arrival, a water tanker was stuck in the wet channel below the crash site. The tanker was filled with the contaminated spill water and the Burns District pump was pumping water up onto the forested hillside.

According to Bill Otani, Heliport manager, cleanup operations began about 5 minutes after the crash. Chemical was diverted into ditches cut near the stream to prevent chemical from reaching the water. Several small dams of soil and grass were put in to reduce the water flow downstream. The contractor had employees removing surface scum as it appeared. Straw was later placed in front of all dams to promote diesel and pesticide collection.

I walked downstream 1/2 mile at 0945 and noticed that there appeared to be no fish kill at the spill site or downstream. The stream, for the first 3/8 mile, was in a meadow area where past beaver or other conditions promoting alluvial deposits had caused the water to spread

out into marshy, wetland conditions. Flow through this grassy area was very slow, sometimes moving at a faster rate where vehicles had once crossed the marsh under drier conditions. A defined channel developed after 3/8 mile causing a confined and meandering channel cut about 2-4 feet into the alluvial material.

The immediate concern to me was that contractor was doing everything possible to reduce the impacts. Frank Joseph, High Life Helicopter contractor representative, asked me if more could be done at 1000 hours. I indicated that the water pumped into the forest should be checked periodically to ensure runoff is not occurring from oversaturated conditions. The hose can be moved if necessary. I also suggested that a few check dams with activated charcoal be placed in the area 3/8 mile downstream where the water was beginning to channelize, that lime be thrown directly into the water to increase the pH and help improve the decomposition of Sevin, and that water from above the crash site could be diverted around the spill area and back into the marsh downstream.

The contractor put in check dams with kitty litter (activated charcoal was not on hand or available locally) and straw. Charcoal briquets crushed were later added to the check dams to promote further absorption of the chemical. Lime was also added to the water moving in the channel at numerous locations and to chemical concentrations on the ground. Efforts at deverting Cow Creek around the spill area were unsuccessful due to the marshy condition and the tractor became stuck. This effort was also aborted due to the damage that was being caused to the meadow.

The following water quality observations were made. No dead fish were seen by me below the spill site. Al Neuman, State Forestry, indicated that he saw a dead dace. At 1100 hours about 1/4 mile below the spill, stressed and dead bloodworms(midge larvae) were seen coming out of the soil channel. Soil channels and marshes are not productive in typical aquatic insects. Some dragon flies were found dead in the marshy water. Ron Wiley, BLM Fishery Biologist was helpful in the identification of impacts and he noticed that dace were stressed 1/4 mile below the spill around noon. Gene Silovsky, Wildlife Biologist and Assistant Environmental Monitor, installed an aquatic drift net about 2.5 miles downstream. I noticed a dead mayfly about 1/2 mile below the spill at 1225. Numerous tadpoles, fish, and certain aquatic bugs were generally not affected. (enclosure)

To complicate the assessment of the downstream impacts, Cow Creek aquatic insects had been already severely impacted do to the 2½ mile site (section 30 NE ¼, NW ¼) with the frequency of Mayfly on channel rocks very rare. Gene Silovsky documented his observation relative to this site.

As expected sufficient chemical was present to cause some downstream impacts. Several things indicated that the downstream impacts would be minor. The stream at the spill site was very slow moving and did not have sufficient turbulence to rapidly put the Sevin and diesel

into suspension. The dewatering and other efforts seemed quite successful in containing and reducing the levels of contaminant. Slow movement through wetland promoted absorption of chemicals onto organics. It is doubtful that more could be done to avoid impacts. Some impacts to aquatic insects relative to spills are expected because the aquatic insects in typical streams are very sensitive to carbaryl concentrations. Brad Bales, ODFWL, was a little abrasive a few times relative to the cleanup and tried to tell the contractor what needed to be done. I do not think he had sufficient experience to understand that he had no authority to tell the contractor what to do unless it was given to him by the DEQ.

The next day the contractor was having the affected soil removed, backfilling with lime and fresh soil. The road cut in to help pull the tanker was also to be put to bed. As of 7-17-83 all of the spill removal was done. Some rehab work was to be completed.

These are notes from the accident as I remember them. See me if more information is needed.

William F. Hansen
Environmental Coordinator

1983 Western Spruce Budworm Suppression Project
USDA, Forest Service
Oregon Department of Forestry
John Day, OR 97845

2540 Water Uses and Development July 20, 1983

Cow Creek Overspray and Spill - King Unit

Randy Perkins, Project Director

Enclosed is a map of the Cow Creek Drainage which was accidently sprayed with Sevin on July 11, 1983, and subject to a Sevin spill on July 13, 1983, from the spray helicopter crash.

Based on field observations made with Bill Otani USFS on July 11 and 12, my observations on July 13 and 14, and those made with Brady Green USFS on July 15, the following was determined:

1. The overspray resulted in a heavy (80%) aquatic insect kill on about two miles of Cow Creek (green line on map).
2. The spill (20 to 40 gallons which entered the creek) resulted in an additional .5 to .75 miles of heavy (90%) aquatic insect kill (red line on map). The contamination from the crash/spill traveled over the same stream reach as the overspray and further reduced the surviving aquatic insects.

The contractors prompt action in (1) liming the insecticide on land and in water, (2) dewatering the creek and (3) daming/filtering the creek significantly reduced the amount of insecticide in the first 400 yards of creek after the spill.

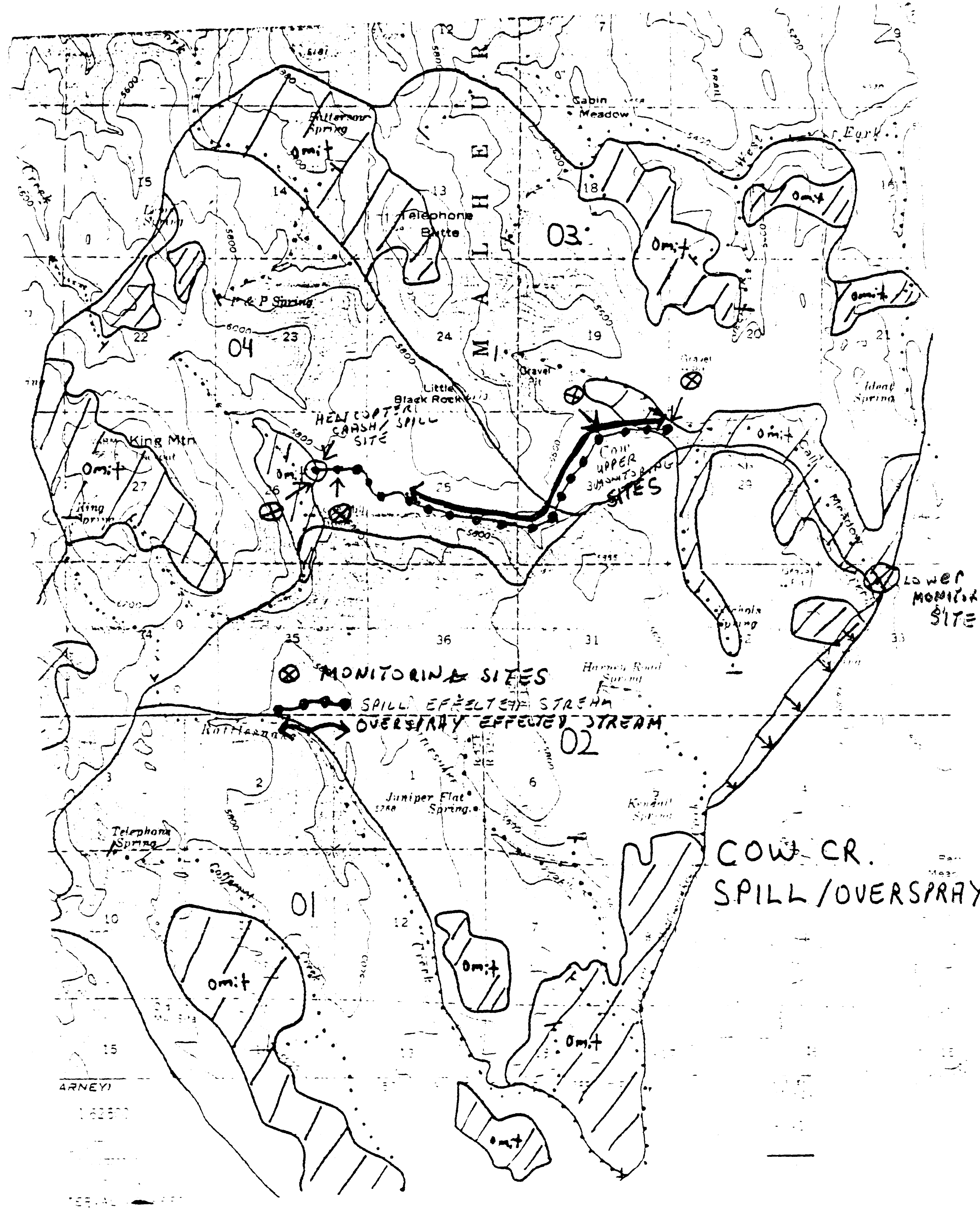
Because of the relatively slow travel time of the creek and high vegetative/organic matter present in this predominately meadow type stream, we assume most of the remaining pesticide will be locked up in the affected area and decompose or be diluted to levels that will not further effect aquatic insects downstream. No dead fish were observed as a result of the overspray or spill. Water samples taken from the overspray and spill are in the process of being analyzed and results will be available next week.

The field notes for these observations are in the possession of Gene Silovsky.

GENE SILOVSKY
Assistant Environmental Monitor

Enclosures

cc: Gene Silvosky
Bill Hansen
Warren Current, Fisheries and Wildlife Staff, Malheur NF
Bill Hosford, ODF&W, Hines


Omit
Cabin Meadow
Telephone Butte
03
04
King Mtn
Little Black Rock
HELICOPTER CRASH/SPILL SITE
COW UPPER MONITORING SITES
LOWER MONITORING SITE
⊗ MONITORING SITES
SPILL EFFECTED STREAM
OVERSPRAY EFFECTED STREAM
02
01
Juniper Flat Spring
Telephone Spring
COW CR.
SPILL/OVERSPRAY

Appendix O
Laboratory Results from Water Monitoring
during 1983 Western Spruce Budworm Project

COLUMBIA
COLUMBIA LABORATORIES INC

East Crown Point Highway P.O. Box 40 Corbett, Oregon 97019 503/695-2287

DATE: 6/17/83

REPORT TO:

Mr. Bill Hansen
U.S. Forest Service
P.O. Box 1131
Grants Pass, OR 97526

SAMPLES: water from spill at Willow Creek

RECEIVED 6/14 and 6/16/83

Lab#	Identification	Carbaryl (Sevin) µg/ml (ppm) MDL= .001ppm
16506	site 3 12:48 Willow cr.	13.8
16507	site 3 15:00 6/13	32.3
16508	site 2 ranch 05:45 6/14	16.5
16509	site 3 water cloudy 13:25 6/13	26.3
16510	site 4 Willow bridge-Heppner 6:35 6/14	2.6
16511	site 2 @ ranch 22:40 6/13	12.5
16515	site 3 Heisport 0528 6/14	14.5
16516	site 1 Willow cr. 2030 6/13	39.9
16517	site 3 14:00 6/13	28.1
16518	site 2 19:50 Hardman ranch 6/13	4.4
16701	below Dam 20:00	ND
16704	S-2 6/14 13:35	5.0
16705	S-3 6/14 12:15	8.7
16706	S-4 6/14 14:05	7.6
16707	S-4 6/14 11:05	8.7
16708	S-4 6/15 11:15	3.1

Shauda Sendele

JUN 23 1983

COLUMBIA

East Crown Point Highway P.O. Box [illegible] Corbett, Oregon 97019 503 695-2287

DATE: 6/20/83

REPORT TO:

Mr. Bill Hansen
U.S.Forest Service
P.O.Box 1131
Grants Pass.OR 97526

Water from spill at Willow Creek

6/17/83

Lab.#	Identification	Carbaryl(Sevin) µg/ml (ppm) MDL=.001ppm µg/l (ppb) MDL= .1ppb
16800	Indian Creek Site 2 1350	73.7 ppb
16801	Indian Creek Sta.1 1402 6/16/83	73.7 ppb
16802	Indian Creek Site1 1830 6/16/83	46.1 ppb
16803	Willow Creek Site4 2210 6/16/83	1.5 ppm
16804.	Willow Creek Site 5 1240 6/16/83	0.5 ppb

Indian Cr = Miller Prairie Spill

Shanda Sendele

AUG 1 1983

COLUMBIA
COLUMBIA LABORATORIES INC
East Crown Point Highway/P.O. Box 40 Corbett. Oregon 97019 503/695-2287

DATE: 7/28/83

REPORT TO:

Mr. Bill Hansen
US Forest Service
P.O. Box 1131
Grants Pass, OR 97526

SAMPLES: water

RECEIVED: 7/15/83

Lab#	Identification	Carbaryl (Sevin) ppb
19612	#1 Wolf Cr 6/30 WOPRWA 2	3.0
19613	#2 Wolf Cr WOPRWA 3	3.2
19614	#3 Tex Cr 6/20 TEPRWA 2	1.7
19615	#4 Murderers Cr. 6/20 MUPRWA 2	2.7
19616	#5 Fivemile Cr 6/16 FMPRWA 2	4.1
19617	#6 Cow Cr upper 7/14 1630 2½ miles below spill	87
19618	#7 Cow Cr 7/14 1540 ¼ mile below spill	231
19619	#8 Cottonwood Cr 7/8 1225 at lower intersection	47
19620	#9 Cat Cr 7/8 0942 intersection 2	53

Lab#	Identification	Zectran ppb
19621	Summit Cr 7/4/83 0904 at mile 9.8	ND

ND= non-detectable
MDL= 1ppb

Shaila Sendele

OCT 17 1983

16381

COLUMBIA

COLUMBIA LABORATORIES, INC

East Crown Point Highway/P.O. Box 40 Corbett, Oregon 97019 503/695-2287

DATE: 10/12/83

REPORT TO:

Mr. Willian Hansen
US Forest Service
P.O. Box 1131
Post Office Building
Grants Pass, OR 97526

SAMPLES: water

RECEIVED: request to do on 9/27/83

Lab#	Identification	Carbaryl (Sevin) ppb
27201	Bridge BRPRWA 3 7/15 0510-7/6 0405	1.4
27202	Bully BUPRWA 2 6/26 0543-6/27 0530	42.8
27203	Deer DEPRWA 2 7/6 1100 to 7/7 0410 rainy	4.4
27204	Lane LAPRWA 2 6/28 1515 to 6/29 1420	5.0
27205	WF Meadow Brook WMPRWA 3 6/18 0810-6/19 0610	1.2
27206	Cottonwood Cr. COPRWA 3 7/9 0635	9.5
27207	Cow Creek 7/15 1540 400yd below spill	83.6
27208	Cow Creek 7/15 1417 2.5mi below spill	44.6
27209	Clear CL PRWA 2 or 3 7/5 0528	1.3
27210	Indian Creek 6/20 1420	20.4
27211	Cottonwood Creek 7/9/83 0857-0930 composite of sites 1,2, & 3	3.7

Sheridan Sendell

is no question that the insecticide entered the stream. In the three Orthene spray sites no residue was reported; however, the residue detection limits of the analytical proceedure was 20 times higher than the residue analysis for Sevin. The laboratories detection for Orthene is 20 ug/liter.

Three quality control samples were sent to the laboratory as a check on field extraction efficiency and analytical accuracy. In one sample 50 ug of Sevin (99.8%) was added directly to 150 ml of methylene chloride, in another, 50 ug Sevin was added to water and field extraction proceedures were used for recovery of the residue, in the third sample 50 ug of Orthene was added to water and sent directly to the laboratory for analysis. Analysis detected 68, 66 and 108 ug respectively of the pesticide residues, an extraction efficiency of 136%, 132% and 216%. The 116% increase in recovery of Orthene could be explained by the difficulty of extraction and elutriation. Analysis for Orthene is not often preformed by contract laboratories.

Invertebrate drift was monitored to determine if there was an increase in organisms as a result of spraying. The drift was monitored by placing a single net in the stream for a 24 hour period as near the insecticide application time as possible. This was the pre-spray or baseline sample. Immediately following spraying of the buffer strips post-spray sampling began and was continued for the following 24 hours. Nets were installed downstream of the lower boundary of the spray unit.

During the period of post-spray sampling, rain produced rising streams and high volume flow. This condition washed large amounts of debris, i.e., conifer needles, twigs, sand and silt, into the nets and caused a certain amount of fouling of the net fabric. Within an hour or sooner, in extremely turbid conditions, back pressure within the net caused considerable net avoidance by the drift. Nets were emptied and cleaned at 6 hour intervals, if possible, to maintain water flow through them. During most of the post-spray sampling, except for Big Creek and Granite Boulder Creek, a drying period allowed streams to return to lower summer flows and less net clogging occured.

It is probable that total water volume passing through the nets during pre- and post-spray sampling remained somewhat constant because of the large differences in flow. The quantity of water passing through the net before clogging, and avoidance, could be close to the volume in a 6 hour period at low flow.

It is known that aquatic insects respond not only to the vicissitudes of stream flow but also to light intensity. As darkness approaches more insects are found in the drift. In general the light intensity of the pre- and post-spray sampling periods was different. Bright, clear, full moon conditions were present on most of the post-spray sample nights, but a full lunar eclipse occurred

Table 1. Numbers and total dry weight in grams (DW) of drifting aquatic invertebrates collected 24 hours before (Pre) and 24 hours after (Post) spraying with Sevin or Orthene during the Spruce Budworm Spray Project, Malheur National Forest, June and July, 1982.

CREEK	TAXA											
	Ephemoptera		Plecoptera		Trichoptera		Diptera		Misc.		Total	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Big Boulder Orthene ND/ND 1/	168	156	4	4	12	36	40	56	20	24	244	276
	.0920	.1276	.0016	.0016	.0052	.0068	.0120	.0132	.0096	.0336	.1204	.1828
Big Boulder, Upper Sevin ND/TR	1380	9220	300	220	220	480	1000	1220	140		3040	11140
	.8480	1.8140	.0320	.0500	.1480	.1900	.4340	.2760	.0036		1.5220	2.3300
Big Orthene ND/ND	192	135	8	15	80	325	32	80	40	80	352	635
	.2640	.1615	.0024	.0050	.0200	.3240	.0128	.0215	.0168	.1505	.3160	.6625
Big, Upper Sevin ND/3.1	170	344	20		45	24	20	72	35	4	290	444
	.0545	.0792	.0060		.0175	.0064	.0070	.0076	.0195	.0060	.1045	.0992
Deardorff Sevin 3.0/1.0	156	824	36	32	12	56	140	856	52	96	396	1864
	.0296	.0744	.0099	.0088	.0012	.0168	.0332	.1712	.0104	.0172	.0843	.2884
Deep Sevin ND/81.0		61080		17000		6720		8160		560		93520
		25.0240		25.7880		12.6240		1.8400		.1820		65.4580
Granite Boulder Orthene ND/ND	123	168	16	20	16	20	16	36	3	24	174	268
	.0486	.0540	.0023	.0028	.0040	.0068	.0017	.0036	.0030	.0108	.0569	.0780
Lick Sevin ND/8.6	112	148		8	16	44	36	140	28	44	192	384
	.0468	.0476		.0036	.0040	.0428	.0084	.0232	.0036	.0068	.0628	.1240
Rail Sevin 1.6/TR	385	310	55	60	35	45	70	100	10	30	555	545
	.0760	.1915	.0190	.0290	.1650	.0745	.0125	.0240	.0525	.0145	.3250	.3335
Reynolds Sevin ND/1.1	212	448	24	72	24	72	76	160	52	84	348	836
	.0320	.0532	.0044	.0136	.0088	.0520	.0176	.0180	.0092	.0270	.0720	.1638

1/ Levels of pesticide found, ND = Not detectable, TR = Trace, Numbers = Parts per billion.

while sampling Rail Creek one night.

Many factors affect invertebrate drift in streams. This should be kept in mind while studying the results of pre- and post-spray drift sampling data on Table 1. One very obvious feature of Table 1 is the data from Deep Creek. The total numbers of invertebrates in the drift, 93,520, is 51 times more than the average of the other nine post-spray samples. It is known that Deep Creek was hit directly with Sevin and it is not surprising to see such large numbers of invertebrates. Unfortunately pre-sample collections were not made on this Creek and Pre- post-spray comparisons are not possible. It could be assumed that the pre-spray numbers would fall within the averages of the other nine pre-spray samples. Deep Creek was the smallest stream of the nine sampled.

It is not possible to explain such large changes in the drift in Big Boulder Creek, Upper. Not only is there a post-spray increase of 266% invertebrates, and only a trace of Sevin chemically detected, but also a 10 fold increase of animals collected in the pre-spray sample over the average of the numbers of animals in the other 8 samples. The other obvious feature on Table 1 is the post-spray invertebrate numbers for Deardorff Creek, an increase of 370% over pre-spray numbers.

The trend in the data tends to point to some type of spray-related effect on the aquatic animals. Care should be taken, however, not to make a strong connection due to the varying climatical and meterological conditions under which the samples were collected and because of the non-statistical sample size of one sample per stream.

<u>Benthic samples</u> of invertebrate organisms living in the stream substrate were collected to determine if a decrease in abundance occured as a result of the spray operation. Benthic samples were collected before spraying and 24 hours after spray began. Collections were made by placing a modified Hess sampler over the stream substrate to be sampled. Sand, gravel and rocks were stirred, dislodged animals were washed into a collecting net mounted on the sampler.

There appears to be no trend in the pre- post-spray samples; 4 out of 10 post-spray samples contained more animals than the pre-spray collections. There is a 19% increase in total post-spray animals collected on the 10 streams. Refer to Table 2 for results of the benthic collections.

It is important to note the value of aquatic insect drift sampling during pesticide spray operations, the effect of water contamination of insecticides to aquatic insects is immediate. On the Deep Creek site an increase in drifting organisms was noticed 30 minutes after the stream was sprayed. Large quantities of aquatic insect larva began filling the drift net and continued for hours thereafter. The applicator was notified immediately of the error. Deep Creek was the first of the 10 streams sampled during the project. At no time was a violation of the buffer zones observed after the Deep Creek overflight.

Table 2. Numbers and total dry weight in grams (DW) of benthic aquatic invertebrates collected before (Pre) and after (Post) spraying with Sevin or Orthene during the Spruce Budworm Spray Project, Malheur National Forest, June and July, 1982.

REEK	TAXA											
	Ephemoptera		Plecoptera		Trichoptera		Diptera		Misc.		Total	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
ig oulder rthene ND/ND 1/	14 .0127	52 .0369	17 .0038	21 .0954	5 .0069	18 .0239	4 .0015	18 .0019	1 .0008	6 .0011	41 .0257	115 .1592
ulder, Upper evin ND/TR	13 .0046	43 .0394	4 .0028	24 .0740	1 .0007	9 .0053	9 .0077	10 .0050	2 .0008	2 .0028	29 .0166	88 .1265
ig rthene ND/ND	16 .0121	20 .0079	4 .0622	1 .0003	9 .0254	4 .0054	14 .0012		39 .0046	3 .0006	82 .1055	28 .0142
ig, pper evin ND/3.1	45 .0097	36 .0107	12 .0822	10 .0019	16 .0376	9 .0347	23 .0174	14 .0010	46 .0115	7 .0020	142 .1584	76 .0503
eardorff evin 3.0/1.0	110 .0366	66 .0326	6 .0014	23 .0044	20 .0378	14 .0046	78 .0236	33 .0151	138 .0392	68 .0134	352 .1386	204 .0701
eep vin ND/81.0	38 .0571	8 .0363	5 .0025		3 .0065	4 .0027	10 .0020	9 .0019	17 .0044	25 .1755	73 .0725	46 .2164
anite ulder thene ND/ND	22 .0171	2 .0005	6 .0030	3 .0007	9 .0272		8 .0002	8 .0009	32 .0107	11 .0017	77 .0582	24 .0038
ck vin ND/8.6	35 .0219	22 .0065	5 .0019	5 .0163	6 .0109	3 .0034	18 .0037	22 .0050	16 .0074	9 .0017	80 .0458	61 .0329
il vin 1.6/TR	29 .0065	62 .0125	36 .1904	65 .0763	13 .0012	14 .0015	27 .0010	64 .0033	142 .0113	465 .0371	247 .2104	670 .1307
ynolds vin ND/1.1	87 .0420	96 .0341	25 .0258	28 .0053	12 .0144	9 .0010	12 .0024	39 .0088	145 .0135	191 .0174	281 .0981	363 .0666

1/ Levels of pesticide found, ND = Not detectable, TR = Trace, Numbers = Parts per billion.